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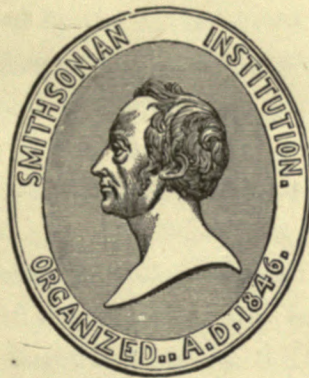
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SMITHSONIAN

15

CONTRIBUTIONS TO KNOWLEDGE.

VOL. XIV.



EVERY MAN IS A VALUABLE MEMBER OF SOCIETY, WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES
KNOWLEDGE FOR MEN.—SMITHSON.

CITY OF WASHINGTON:
PUBLISHED BY THE SMITHSONIAN INSTITUTION.

MDCCCLXV..

1865

ADVERTISEMENT.

THIS volume forms the fourteenth of a series, composed of original memoirs on different branches of knowledge, published at the expense, and under the direction, of the Smithsonian Institution. The publication of this series forms part of a general plan adopted for carrying into effect the benevolent intentions of JAMES SMITHSON, Esq., of England. This gentleman left his property in trust to the United States of America, to found, at Washington, an institution which should bear his own name, and have for its objects the "*increase and diffusion* of knowledge among men." This trust was accepted by the Government of the United States, and an Act of Congress was passed August 10, 1846, constituting the President and the other principal executive officers of the general government, the Chief Justice of the Supreme Court, the Mayor of Washington, and such other persons as they might elect honorary members, an establishment under the name of the "SMITHSONIAN INSTITUTION FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE AMONG MEN." The members and honorary members of this establishment are to hold stated and special meetings for the supervision of the affairs of the Institution, and for the advice and instruction of a Board of Regents, to whom the financial and other affairs are intrusted.

The Board of Regents consists of three members *ex officio* of the establishment, namely, the Vice-President of the United States, the Chief Justice of the Supreme Court, and the Mayor of Washington, together with twelve other members, three of whom are appointed by the Senate from its own body, three by the House of Representatives from its members, and six persons appointed by a joint resolution of both houses. To this Board is given the power of electing a Secretary and other officers, for conducting the active operations of the Institution.

To carry into effect the purposes of the testator, the plan of organization should evidently embrace two objects: one, the increase of knowledge by the addition of new truths to the existing stock; the other, the diffusion of knowledge, thus increased, among men. No restriction is made in favor of any kind of knowledge; and, hence, each branch is entitled to, and should receive, a share of attention.

The Act of Congress, establishing the Institution, directs, as a part of the plan of organization, the formation of a Library, a Museum, and a Gallery of Art, together with provisions for physical research and popular lectures, while it leaves to the Regents the power of adopting such other parts of an organization as they may deem best suited to promote the objects of the bequest.

After much deliberation, the Regents resolved to divide the annual income into two parts—one part to be devoted to the increase and diffusion of knowledge by means of original research and publications—the other part of the income to be applied in accordance with the requirements of the Act of Congress, to the gradual formation of a Library, a Museum, and a Gallery of Art.

The following are the details of the parts of the general plan of organization provisionally adopted at the meeting of the Regents, Dec. 8, 1847.

DETAILS OF THE FIRST PART OF THE PLAN.

I. TO INCREASE KNOWLEDGE.—*It is proposed to stimulate research, by offering rewards for original memoirs on all subjects of investigation.*

1. The memoirs thus obtained, to be published in a series of volumes, in a quarto form, and entitled "Smithsonian Contributions to Knowledge."

2. No memoir, on subjects of physical science, to be accepted for publication, which does not furnish a positive addition to human knowledge, resting on original research; and all unverified speculations to be rejected.

3. Each memoir presented to the Institution, to be submitted for examination to a commission of persons of reputation for learning in the branch to which the memoir pertains; and to be accepted for publication only in case the report of this commission is favorable.

4. The commission to be chosen by the officers of the Institution, and the name of the author, as far as practicable, concealed, unless a favorable decision be made.

5. The volumes of the memoirs to be exchanged for the Transactions of literary and scientific societies, and copies to be given to all the colleges, and principal libraries, in this country. One part of the remaining copies may be offered for sale; and the other carefully preserved, to form complete sets of the work, to supply the demand from new institutions.

6. An abstract, or popular account, of the contents of these memoirs to be given to the public, through the annual report of the Regents to Congress.

II. TO INCREASE KNOWLEDGE.—*It is also proposed to appropriate a portion of the income, annually, to special objects of research, under the direction of suitable persons.*

1. The objects, and the amount appropriated, to be recommended by counsellors of the Institution.

2. Appropriations in different years to different objects; so that, in course of time, each branch of knowledge may receive a share.

3. The results obtained from these appropriations to be published, with the memoirs before mentioned, in the volumes of the Smithsonian Contributions to Knowledge.

4. Examples of objects for which appropriations may be made:—

(1.) System of extended meteorological observations for solving the problem of American storms.

(2.) Explorations in descriptive natural history, and geological, mathematical, and topographical surveys, to collect material for the formation of a Physical Atlas of the United States.

(3.) Solution of experimental problems, such as a new determination of the weight of the earth, of the velocity of electricity, and of light; chemical analyses of soils and plants; collection and publication of articles of science, accumulated in the offices of Government.

(4.) Institution of statistical inquiries with reference to physical, moral, and political subjects.

(5.) Historical researches, and accurate surveys of places celebrated in American history.

(6.) Ethnological researches, particularly with reference to the different races of men in North America; also explorations, and accurate surveys, of the mounds and other remains of the ancient people of our country.

I. TO DIFFUSE KNOWLEDGE.—*It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional.*

1. Some of these reports may be published annually, others at longer intervals, as the income of the Institution or the changes in the branches of knowledge may indicate.

2. The reports are to be prepared by collaborators, eminent in the different branches of knowledge.

3. Each collaborator to be furnished with the journals and publications, domestic and foreign, necessary to the compilation of his report; to be paid a certain sum for his labors, and to be named on the title-page of the report.

4. The reports to be published in separate parts, so that persons interested in a particular branch, can procure the parts relating to it, without purchasing the whole.

5. These reports may be presented to Congress, for partial distribution, the remaining copies to be given to literary and scientific institutions, and sold to individuals for a moderate price.

The following are some of the subjects which may be embraced in the reports:—

I. PHYSICAL CLASS.

1. Physics, including astronomy, natural philosophy, chemistry, and meteorology.
2. Natural history, including botany, zoology, geology, &c.
3. Agriculture.
4. Application of science to arts.

II. MORAL AND POLITICAL CLASS.

5. Ethnology, including particular history, comparative philology, antiquities, &c.
6. Statistics and political economy.
7. Mental and moral philosophy.
8. A survey of the political events of the world; penal reform, &c.

III. LITERATURE AND THE FINE ARTS.

9. Modern literature.
10. The fine arts, and their application to the useful arts.
11. Bibliography.
12. Obituary notices of distinguished individuals.

II. TO DIFFUSE KNOWLEDGE.—*It is proposed to publish occasionally separate treatises on subjects of general interest.*

1. These treatises may occasionally consist of valuable memoirs translated from foreign languages, or of articles prepared under the direction of the Institution, or procured by offering premiums for the best exposition of a given subject.

2. The treatises to be submitted to a commission of competent judges, previous to their publication.

DETAILS OF THE SECOND PART OF THE PLAN OF ORGANIZATION.

This part contemplates the formation of a Library, a Museum, and a Gallery of Art.

1. To carry out the plan before described, a library will be required, consisting, 1st, of a complete collection of the transactions and proceedings of all the learned societies of the world; 2d, of the more important current periodical publications, and other works necessary in preparing the periodical reports.

2. The Institution should make special collections, particularly of objects to verify its own publications. Also a collection of instruments of research in all branches of experimental science.

3. With reference to the collection of books, other than those mentioned above, catalogues of all the different libraries in the United States should be procured, in order that the valuable books first purchased may be such as are not to be found elsewhere in the United States.

4. Also catalogues of memoirs, and of books in foreign libraries, and other materials, should be collected, for rendering the Institution a centre of bibliographical knowledge, whence the student may be directed to any work which he may require.

5. It is believed that the collections in natural history will increase by donation, as rapidly as the income of the Institution can make provision for their reception; and, therefore, it will seldom be necessary to purchase any article of this kind.

6. Attempts should be made to procure for the gallery of art, casts of the most celebrated articles of ancient and modern sculpture.

7. The arts may be encouraged by providing a room, free of expense, for the exhibition of the objects of the Art-Union, and other similar societies.

8. A small appropriation should annually be made for models of antiquity, such as those of the remains of ancient temples, &c.

9. The Secretary and his assistants, during the session of Congress, will be required to illustrate new discoveries in science, and to exhibit new objects of art; distinguished individuals should also be invited to give lectures on subjects of general interest.

In accordance with the rules adopted in the programme of organization, each memoir in this volume has been favorably reported on by a Commission appointed

for its examination. It is however impossible, in most cases, to verify the statements of an author; and, therefore, neither the Commission nor the Institution can be responsible for more than the general character of a memoir.

The following rules have been adopted for the distribution of the quarto volumes of the Smithsonian Contributions:—

1. They are to be presented to all learned societies which publish Transactions, and give copies of these, in exchange, to the Institution.
2. Also, to all foreign libraries of the first class, provided they give in exchange their catalogues or other publications, or an equivalent from their duplicate volumes.
3. To all the colleges in actual operation in this country, provided they furnish, in return, meteorological observations, catalogues of their libraries and of their students, and all other publications issued by them relative to their organization and history.
4. To all States and Territories, provided there be given, in return, copies of all documents published under their authority.
5. To all incorporated public libraries in this country, not included in any of the foregoing classes, now containing more than 10,000 volumes; and to smaller libraries, where a whole State or large district would be otherwise unsupplied.

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PALÆONTOLOGY
OF THE
UPPER MISSOURI:

A REPORT UPON COLLECTIONS MADE PRINCIPALLY BY THE EXPEDITIONS UNDER
COMMAND OF LIEUT. G. K. WARREN, U. S. TOP. ENGRS., IN 1855 AND 1856.

INVERTEBRATES.

BY

F. B. MEEK AND F. V. HAYDEN, M.D.

PART I.

ACCEPTED FOR PUBLICATION, MAY, 1864.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

ISAAC LEA.
Prof. JAMES D. DANA.

JOSEPH HENRY,
Secretary S. I.

COLLINS, PRINTER,
PHILADELPHIA.

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INTRODUCTION.

THE following Memoir is the first part of a work intended to contain descriptions and illustrations of the invertebrate fossil remains collected by the Exploring Expeditions under the command of Lieut. (now Maj.-Gen.) G. K. Warren, as well as by Dr. Hayden and others, in the Upper Missouri country.¹ It was originally prepared with the expectation that it would form part of Lieut. Warren's official report to the War Department, but circumstances having prevented the final completion of the latter, with the concurrence of Lieut. Warren, the Memoir was offered to the Smithsonian Institution by the authors for publication in the Smithsonian Contributions to Knowledge.

Much the larger proportion of these collections being from the Cretaceous and Tertiary rocks, which occupy almost the entire surface of the great area explored, it was at first intended to confine the work entirely to the full illustration and description of the fossils of these two epochs. The subsequent interesting discovery, however, of Jurassic and Primordial rocks, with the intermediate Carboniferous beds at the Black Hills and a few other localities, and of the Permian in Kansas, rendered it necessary that some attention should also be given to the organic remains of these older deposits. Yet as the Carboniferous beds, which are very fossiliferous, only occupy inconsiderable portions of the country to be reported upon, while a large number of the fossils occurring in them are identical with forms already published in various State and General Government Reports, and elsewhere, it has not been deemed desirable to attempt to include all the known species from the rocks of that age within the field of exploration, as this alone would require an extensive work. The plan adopted, therefore, is to give full descriptions and figures of all the known Tertiary, Cretaceous, Jurassic, and Primordial fossils of this region; together with the new, and a few otherwise interesting forms, contained in the collections from the Permian and Carboniferous rocks of Kansas and Southeastern Nebraska.²

The first part of this work, now presented, includes the Primordial, Carboniferous,³ Permian, and Jurassic species, which constitute but a small proportion of

¹ This great extent of country was formerly known under the general name of Nebraska Territory, but has been recently divided into Dakota, Nebraska, and Montana Territories.

² No middle or upper Silurian, or Devonian beds, have yet been identified by fossils, at any locality in the country explored, north of the South Pass.

³ It is proper to state, for the information of those not acquainted with the geology of the western Territories, that the few carboniferous species here figured were not selected, with one or two excep-

the whole. The next part, which will be the largest, will contain the Cretaceous species, and the third the Tertiary. Along with the second or third part, an introductory chapter will be presented, giving a general sketch of the geological formations from which these fossils were collected; their geographical range, lithological characters, thickness, &c.; with remarks on their relations to formations further eastward, both in this country and Europe.

In order to make the work as useful as possible to students, descriptions of the genera and families to which these fossils belong have also been added. Under each family, all the genera, both recent and fossil, believed to be properly included, are mentioned; while the relations of the genera described are discussed, and at the head of each generic description the synonyms, with full references, are given; likewise, when known, the etymology of the name, and the typical species of each genus. The probable periods at which the several genera, as defined, were introduced, when they attained their maximum development, and at what time they seem to have died out, if not represented in our existing seas, are also stated.

The portion of the work now presented, contains a larger amount of text, in proportion to the number of species figured and described, than will be found in the succeeding parts, in consequence of the fact that descriptions of a number of genera and families are here given which it will not be necessary to repeat, the plan being to refer back to these descriptions when other species belonging to any of these groups come to be mentioned subsequently.

From the references at the head of the specific descriptions it will be seen that preliminary notices of most of the species have been published, from time to time, under the joint names of the authors, in the Proceedings of the Philadelphia Academy of Natural Sciences. Subsequently these descriptions have been almost entirely rewritten, and extended, by the senior author (Mr. Meek), who has likewise prepared the accompanying descriptions of genera and families, with the remarks on their relations, geological and geographical range, &c.

The authors avail themselves of this opportunity to acknowledge their obligations to Prof. Henry for the use of rooms, books, and other facilities at the Smithsonian Institution, during the progress of the work: also to Prof. Dana and Prof. Agassiz, for the use of a few rare works, not in the Smithsonian library.

They are also under obligations to most of the geologists and palæontologists of the country, either for information in regard to types described by them, or respecting the geological range of particular forms in their several fields of observation. In this connection they take pleasure in mentioning the names of Mr. T. A. Conrad and Mr. Wm. M. Gabb, of Philadelphia; Dr. B. F. Shumard, of St. Louis; Mr. E. Billings, of the Canadian Geological Survey; Prof. George H. Cook, State Geologist of New Jersey; Mr. A. H. Worthen, State Geologist of Illinois; and Prof. A. Winchell, State Geologist of Michigan.

tions, as examples of the more characteristic forms found in rocks of that age here, but because they are either new to science, or have not been previously well illustrated in this country. Geologists, however, may rest assured that they all occur directly associated with all our most common western Coal Measure species.

To the several conchologists and laborers in other departments of Natural History, with whom they have more or less freely communicated, and from whom they have received occasional suggestions, they desire to express their thanks, without having it thereby understood that any of these gentlemen are responsible for conclusions finally adopted. Those to whom their acknowledgments are more especially due are, Dr. Wm. Stimpson, and Prof. Theo. Gill, of Washington, D. C.; Dr. A. A. Gould, of Boston; Dr. Isaac Lea and Mr. Geo. W. Tryon, of Philadelphia; Dr. P. P. Carpenter, of Warrington, England; Mr. W. G. Binney, of Burlington, New Jersey; Mr. J. G. Anthony, of Cincinnati; and Mr. Temple Prime and Thomas Bland, of New York.

Most of the published works on Geology, Palæontology, and Conchology have been consulted during the preparation of the work, and a list of these will be appended to one of the succeeding parts.

PALEONTOLOGY OF THE UPPER MISSOURI.

SILURIAN AGE.

(POTSDAM OR PRIMORDIAL PERIOD.)

MOLLUSCA.

CLASS BRACHIOPODA.

FAMILY LINGULIDÆ.

Shell subequivalve, hingeless, oblong, oval, subtrigonal, or suborbicular, covered with a corneous epidermis; texture subcorneous or testaceous; structure laminated and minutely tubular or more or less compact; interior without calcified spiral or loop-like appendages.

Animal with elongated fleshy, subspiral oral arms, situated on each side of the mouth, and fringed with numerous cirrhi; attached by a thick peduncle passing out between the beaks of the valves; mantle highly vascular, and fringed with corneous setæ.

This family includes the four known genera, *Lingula*, *Lingulepis*, *Obolus*, and *Obolella*? It was introduced at the dawn of the Silurian age, and is represented in all the succeeding formations, as well as in our existing seas.

Genus LINGULEPIS, HALL.

Synon.—*Lingula* (sp.), OWEN, Report Wisconsin, Iowa and Minnesota, 1852, p. 583; HALL, Foster & Whitney's Report Lake Sup. part ii, 1851, p. 204; MEEK & HAYDEN, Proceed. Acad. Phila. 1858, p. 49 (not *Lingula*, BRUG. 1792).

Lingulepis, HALL, Sixteenth Ann. Rept. Regents' University, N. Y., 1863, p. 129.

Etym.—*Lingula*, a little tongue; *æpis*, a scale.

Type.—*Lingula pinniformis*, OWEN.

Shell thin, subovate, or subtrigonal; composition and structure as in *Lingula*. Ventral or larger valve with beak more or less produced and pointed; visceral scar trilobate, with a longitudinal raised mesial line or septum—lateral divisions diverging and usually longer than the middle one. Dorsal or smaller valve with the beak less produced than that of the other; visceral scar flabelliform.

The above description is mainly as given by the author of the genus, excepting that we have described the markings seen within the valves as visceral scars instead of muscular impressions, and left out a few such characters as "inequivalve, equilateral," &c., which being common to all the genera of the family, and indeed normally characteristic of the whole class, need not be repeated in a generic description. We

would remark, however, that we have had an opportunity to examine a collection of the typical species from the falls of St. Croix, recently deposited in the museum of the Smithsonian Institution, and that we have seen the peculiar visceral scar shown in the form supposed to be the smaller or dorsal valve of the same. The specimens of the other valve, we have seen, are not in a condition to show so clearly the trilobate visceral scar, though a few of them exhibit traces of its outline. From the examination of these specimens, and the published figures, we are clearly satisfied that these internal markings are the scars of the visceral sack, and not, as has been supposed, "muscular impressions." The impressions of the posterior occlusor muscles are located much as in *Lingula*, one on each side of the middle lobe of the visceral scar, in the sinus between it and the lateral lobe on each side.¹ In the other valve the minute impressions of these muscles are placed apparently within the middle lobe of the flabelliform visceral scar, much as in *Lingula*, excepting that they are closer together, and located a little farther back.

It will thus be seen that the arrangement of the muscular system in this ancient type has yet to be clearly defined, and that it is much more nearly related to the genus *Lingula* than has been supposed; though the differences in the nature of the visceral scars, and the general form of the shell, were probably coincident with differences in the structure of the animal that would place this type in a distinct genus from our modern *Lingulas*.

The only species yet positively known to possess the characters of this genus, is from the base of the Silurian System, though it is probable many—possibly all—of the older Palæozoic species usually referred to the genus *Lingula*, will be found to belong here. Until the interior of many species have been examined, nothing can be known in regard to the geological range of the genus. So far, however, as can be determined from external form alone, it seems to range up at least to the Medina Sandstone of N. York Upper Silurian Series—*Lingula cuneata* of Conrad, from that rock, having more nearly the outline of the typical species of this genus than that of the modern *Lingulas*.

Lingulepis pinniformis.

(PLATE I, Fig. 1, a, b.)

Lingula antiqua, HALL, Foster & Whitney's Report Lake Superior, 1851, p. 204, pl. xxiii, Fig. 2.—MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila., March, 1858, p. 49 (not HALL, 1847).

Lingula pinniformis, OWEN, Rept. Geol. Wisconsin, Iowa, and Minnesota, 1852, pl. 1, B, Figs. 4, 6, 8, &c.

Lingulepis pinniformis, HALL, Sixteenth Report Regents' University, N. Y., 1863, p. 129, pl. vi, Figs. 14 and 16.

Shell subovate, or ovate-subtrigonal, rounded in front and angular at the beaks, moderately convex; sides converging to the beaks, with straight or concave outlines. Beaks more or less produced, that of the larger valve attenuate and acutely pointed. Surface marked by rather obscure concentric striae, which are sometimes crossed by faint radiating lines, usually most apparent on exfoliated surfaces, and generally quite distinct near the front, on the interior surface, and on internal casts.

Length, 0.68 inch; breadth, 0.50 inch. Other individuals in the collection proportionally wider.

This shell agrees so nearly in outline with the Escanaba form figured by Prof.

¹ On comparing the trilobate visceral scar of the larger valve in *Lingulepis*, with that of the same valve in the recent *Lingula anatina*, as figured by Mr. Davidson (Mon. Carb. Brach. Grt. Brt., p. 200), it will be seen that they are very similar, excepting in the greater prolongation of the lateral lobes in *Lingulepis*.

Hall, in Foster and Whitney's Report, as a variety of *Lingula antiqua*, that we were led to refer it to that species, not having specimens of the New York shell at hand for comparison. Nor had we at that time within reach, specimens of the Wisconsin form now made the type of the new genus *Lingulepis*. On comparison with specimens of the latter, however, we find our shells agree so nearly with them that we do not feel fully warranted in considering them distinct, though some slight differences seem to be observable. They have the same general form and attenuate beak, but appear to differ in having the beak of the larger valve more flattened towards the pointed extremity; still the species *pinniformis* seems to vary somewhat in this respect, and as our specimens are in a bad state of preservation we are not sure these differences are constant.

Should a comparison of better specimens show our shell to be distinct, it may take the name *Lingulepis dakotensis*.

Locality and position. Central part of Black Hills, Dakotah Territory. Potsdam Sandstone, at the base of the Silurian system. (No. 1026a, type of description and figure, Smithsonian Collection.)

Lingulepis prima.

(PLATE I, Fig. 2, a, b.)

Lingula prima (CONRAD) HALL, Palæont., New York, I, 1847, 3, Pl. i, Fig. 2, a, b.—HALL, Foster and Whitney's Rept. Lake Superior, 204, 1851, Pl. xxiii, Fig. 1.

Shell small, ovate, rather gibbous, and comparatively thick; rounded in front; sides more or less convex in outline; beaks obtuse and convex; surface marked by obscure lines of growth, and more or less distinct radiating striæ; the latter most strongly defined on exfoliated surfaces.

Length, 0.18 inch; breadth, about 0.14 inch; convexity (larger valve), 0.03 inch.

Our specimens are generally worn, or more or less exfoliated, but as near as can be determined they seem to agree with the above cited New York species. We refer them to the genus *Lingulepis*, provisionally, not having seen the muscular impressions, but believing it to be more than probable that most, if not all of the older Palæozoic species of this general form, will be found to possess the internal characters of that genus.

We would have suspected that these shorter and more oval specimens might be the dorsal valves of the *pinniformis*, were it not for their smaller size, and the fact that they are much more convex than those supposed to be the smaller valve of that species from St. Croix River.

Locality and position, same as last. (No. 1027a, and 1027b.)

Genus OBOLELLA, BILLINGS.

Synon.—*Obolella*, BILLINGS, New. sp. Sil. Foss. Nov. 1861, 7, fig. 6, a, b, c, d.

Avicula? (desquamata), HALL, Pal. New York, I, 1852, p. 292, pl. 80, f. 3.

Lingula? (desquamata), HALL, Twelfth Rept. Regents' University, N. Y., Oct. 1859, p. 66.

Etym.—Diminutive of *Obolus*, the name of a small Greek coin.

Type.—*Obolella chromatica*, BILLINGS.

"Shell ovate circular or subquadrate, convex or plano-convex. Ventral valve with a false area which is sometimes minute and usually grooved for the passage of the peduncle. Dorsal valve either with or without an area. Muscular impres-

sions in the ventral valve, four; one pair in front of the beak near the middle or in the upper half of the shell, and the others situated one on each side near the cardinal edge. Shell calcareous. Surface concentrically striated, sometimes with thin extended lamellose edges."

"In general form these shells somewhat resemble *Obolus*, but the arrangement of the muscular impressions is different. In *Obolus* the two central scars have their smaller extremities directed downwards, converging towards each other; but in this genus the arrangement is exactly the reverse."—BILLINGS.

The six or eight known species of this genus, are small shells, and all occur near the base of the Silurian System. The group has a wide geographical range.

Obolella nana.

(PLATE I, Fig. 3, a, b, c, d.)

Obolella nana, MEEK & HAYDEN, Proceedings Acad. Nat. Sciences, Philadelphia, October, 1861, 435.—HAYDEN, Amer. Journ. Sciences, XXXIII, 1861, 2d ser. p. 73.—DANA's Geology, p. 187, Fig. 244 A.

Shell very small, subcircular or transversely suboval; moderately convex; rather thick; front broadly rounded; sides more narrowly rounded. Beak of dorsal valve short and obtuse. Ventral valve proportionally a little longer than the other, or about as wide as long, and having a slightly more prominent beak; without a distinct mesial ridge within; scar of anterior adductor muscle? located behind the middle; impressions of sliding muscles narrow; cardinal area rather narrow and flattened; groove for the passage of the peduncle shallow. Surface marked by a few small concentric grooves or impressed striæ; exfoliated specimens showing small regularly disposed radiating striæ.

Length of dorsal valve, 0.15 inch; breadth of do., 0.17 inch; convexity, 0.15 inch. Length and breadth of a ventral valve of a smaller specimen each, 0.14 inch.

This species is so closely allied to *Obolella chromatica* of Billings, the type of the genus ("New Species, Lower Sil. Foss." p. 7), that we were inclined to regard it as specifically identical, until we had an opportunity to compare it with specimens of Mr. Billings' species sent to us by him. On comparing it with these, we find it is more convex, and proportionally broader, while its concentric markings are stronger. The substance of its shell differs in showing radiating striæ on the inner laminae of exfoliated specimens.

Locality and position, same as last. (No. 1025.)

CLASS GASTEROPODA.

SUB-CLASS PTEROPODA.

Order Thecosmata.

FAMILY CAVOLINIDÆ.

Shell non-spiral, symmetrical, more or less elongate-conical, or subglobose, curved or straight; the subglobose, and a few of the more elongate forms, provided with lateral fissures for the passage of the mantle.

Animal with two united wing-like fins, but without a foot; abdomen large; gills in pairs on the ventral side within the mantle cavity, transversely plaited and ciliated. Internal superior organs of generation on the right side. Lingual teeth 1, 1, 1 (in *Cavolina*), claw-shaped.

This family includes the following genera represented in our existing seas, viz: *Carolina*, *Pleuropus*, *Clio*, *Balantium*, *Styliola* and *Cuvieria*. The extinct genera most probably belonging here, are *Theca*, *Salterella*, *Vaginella* and *Pterotheca*? The fossil shells *Conularia* and *Coleoprion*, are also generally referred to this family, but if there is no mistake about the existence of septa and a siphuncle in the former genus (see *Conularia trentonensis*, Pal. N. Y. Vol. I, p. 221, f. 4), it would be excluded, not only from this family, but probably from the subclass *Pteropoda*.

Genus *THECA*, SOWERBY.

Synon.—*Theca*, J. de C. SOWERBY, MSS., in Morris' Memoir, Strezelscki's N. S. Wales, 1845, p. 289.

Pugiunculus, BARRANDE, Neues Jahrb. für Min. 1847, p. 354.

Etymol.—*Sin*, a sheath, case or covering.

Type.—*Theca lanceolata*, MORRIS.

Shell thin, more or less elongate-conical, nearly or quite straight; aperture and section trigonal or subtrigonal; surface smooth or striated. (Animal unknown.)

According to Prof. Barrande (who had not seen the description of the genus *Theca* at the time he proposed the name *Pugiunculus*), the aperture of these little shells was closed by a triangular shelly operculum. This would seem to be a rather anomalous character in the family to which this group appears to belong.

The genus *Theca* commenced its existence amongst the earliest forms of life during the primordial period, and its remains are found in various parts of the Silurian system, both upper and lower; though it probably attained its greatest development during the deposition of the Lower Silurian rocks. It is also known to range up into the Devonian, two species having been described by Sandberger from deposits of that age in the Rheinisch Provinces. As one species—*T. aculeata*, Hall—has been discovered in beds in this country holding a position near the dividing line between Devonian and Carboniferous rocks, it is probable the genus did not become entirely extinct until some time after the close of the Carboniferous epoch.

Theca gregaria.

Theca (Pugiunculus) gregaria, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila., December, 1861, p. 436.—DANA's Geology, p. 187, Fig. 244 B.

Shell small, straight, acutely conical; dorsal side compressed or nearly flat; ventral side rounded; lateral margins obtusely angular, and converging regularly at an angle of about 18° to the pointed lower extremity; aperture and transverse section nearly semicircular, or forming rather more than half a circle; lip on the flat or dorsal side somewhat produced, and rounded in outline; surface of casts nearly or quite smooth.

Length, 0.45 inch; breadth, 0.15 inch; convexity, 0.10 inch at the aperture.



Theca gregaria.

a. Ventral side. b. Dorsal side. c. Side view. d. Transverse section.

These delicate little shells must have existed in great numbers, since on a single flat piece of sandstone, not more than six by eight inches across, we have counted

near two hundred individuals, and yet they occur in all parts of the mass, so that every new surface exposed in splitting it, is seen to be covered with them. They are not crushed or distorted in the slightest degree, and are all casts, the shell itself being in no instance preserved.

The species is allied to *Theca? triangularis*, Hall (Palæont. N. Y. Vol. I, p. 313, Pl. lxxxvii, Fig. 1 *a, b, c, d*), but never attained near so large a size, and is more rounded on the ventral side. It is probably more nearly related to *T. primordialis*, Hall (An. Rept. Geol. Survey Wisconsin, 1861? p. 80), but never attains more than about half the linear dimensions of that species, and we have seen no traces of the arching undulations on its flat side, mentioned in the description of *T. primordialis*, though some of the impressions in the matrix show very faint indications of fine arching transverse striæ on this side. In size and form it agrees quite closely with *Salterella obtusa* of Billings (New. Sp. Low. Sil. Foss., p. 18, Montreal), but it seems to be a thinner shell, and shows no evidences of being composed of successive layers, nor is it provided with the sharp annulations seen in the type of that genus.

Locality and position. Near the head of Powder River, in Big Horn Mountain, Idaho Territory. From the Potsdam or Primordial Sandstone. (No. 1181.)

ARTICULATA.

CLASS CRUSTACEA.

ORDER? Trilobita.

FAMILY PARADOXIDÆ.

Head well developed, sometimes very large; facial sutures generally subparallel, especially the anterior portion; ribs each provided with a longitudinal furrow. Thorax large, consisting of from twelve to twenty segments. Pygidium very small, and always with few segments.

This family includes the genera *Paradoxides*, *Olenus*, *Olenellus*, *Peltura*, *Sao*, *Hydrocephalus*, *Triarthrus*, *Agraulos*, *Ellipsocephalus*, *Conocoryphe*,¹ and probably *Ptychaspis*, *Chariocephalus*, *Crepicephalus* and *Menocephalus*. It embraces a considerable number of species, some of which attain a very large size. They are generally remarkable for the great development of the thorax, compared with the small size of the pygidium. The whole family, with the exception of *Triarthrus*, seems to be mainly, if not entirely, confined to the *Primordial* or oldest group of fossiliferous rocks.

Genus AGRAULOS, CORDA.

Synon.—*Arion*, BARRANDE, Note Prélim. 1846, 12 (not Ferrussac, 1819).

Herse, CORDA, Prodr. 1847 (not Oken, 1815, nor Lesson, 1837).

Agraulos, CORDA, ib. 1847.

Arionides (BARRANDE, MSS.), BRONN, Index Pal., 1848, 103.

Arionellus, BARRANDE, Syst. Sil. Boh. 1852.

Crepicephalus? (part), OWEN, Report Geol. Survey, Wisconsin, Iowa and Minnesota, 1852, p. 576.

Etymol.—*Ἀγρᾶυλος*, daughter of the first King of Athens.

Type.—*Arion ceticephalus*, BARRANDE.

Entire animal more or less elongate-ovate, distinctly trilobate. Head forming more than a semicircle, nearly straight behind; glabella conoid-subovate, provided, in young examples, with three or four lateral furrows, which are usually nearly or quite obsolete in the adult, margined in front by a more or less developed border connecting with the cheeks on each side. Facial sutures widely separated, extending and converging forward from the eyes so as to intersect the anterior margin within a point where a line would strike it if drawn through each eye,

¹ *Conocoryphe*, Corda, 1847 = *Conocephalus*, Zenker, 1833 (not Thunberg, 1812) = *Conocephalites*, Barrande, 1852.

parallel to the longer axis of the body; behind the eyes they diverge and extend backwards, so as to cut the straight posterior margin somewhat within the lateral angles. Checks small and narrow; eyes small. Hypostoma oval, truncated anteriorly. Segments of body in the adult of the typical species, sixteen; in the pygidium three.

As stated by Barrande, this genus presents several points of analogy to *Paradoxides*, particularly in the arrangement of its facial sutures, and the great number of its thoracic segments, as well as in the small size of its pygidium. In Europe it is only known to have been represented by the single typical species, which is confined to the primordial zone. Several species have been described from rocks of the same age in America, and the genus is not certainly known to have existed after the close of the Primordial epoch.

We would with pleasure adopt the name *Arionellus*, proposed for this genus by Prof. Barrande, in his splendid work on the Trilobites of Bohemia, if we could do so consistently with the just and inflexible law of priority, which we have endeavored to obey in all cases. The fact that Corda's first name, *Herse*, was applied to a young individual, would not, we should think, be a sufficient reason for setting it aside, especially as no doubt can be entertained of its generic, and even specific identity with the type of *Arionellus*. It cannot stand, however, for the reason that it had been used by Oken, in 1815, for a genus of *Lepidoptera*, and by Lesson for a genus of Birds in 1837. The next name, then, that we are compelled to consider, is *Agraulos*, which Prof. Barrande thinks should be rejected, in consequence of its similarity to *Agraulis*, used by Boisduval, in 1836, for a genus of *Lepidoptera*. These names, however, seem to us to be sufficiently distinct to prevent confusion; certainly they are as much so as many others retained in various departments of natural history—such, for instance, as *Trigonia* and *Trigona*, in Conchology, *Cypripina* and *Cypripinus*, in Conchology and Ichthyology, and *Pica* and *Picus*, in Ornithology.

We should also feel constrained, on the same principle, to adopt Corda's first name *Conocoryphe*, instead of *Conocephalus* or *Conocephalites*. The reasons for so doing will be better understood by the following statement of the synonymy of this genus. In the first place Zenker named it *Conocephalus*, in 1833. Finding this name had been used, however, in 1812, for a genus of *Orthoptera*, by Thunberg, he changed it in the explanations of his figures in the same work, to *Trigonocephalus*, which had also been previously used by Oppel for a genus of Reptiles, in 1811. In 1847, Corda applied the three generic names, *Conocoryphe*, *Ptychoparia* and *Ctenocephalus* to three species of this same genus of *Trilobites*. In 1852, Prof. Barrande, seeing that none of the older names could be adopted for this group, also rejected Corda's names, on the ground that he had, without sufficient reason, divided the genus, and that as no one of his names was applied to the whole group, he was opposed to retaining either of them, and consequently proposed the new name *Conocephalites*. The law of priority, however, requires us to adopt the first unoccupied name in this and in all other cases where no doubt can be entertained in regard to the generic identity of its type with the types of the sub-

sequently proposed genera. The other names applied by Corda fall into the list of synonyms, just as if they had been proposed by any other author at any subsequent time.

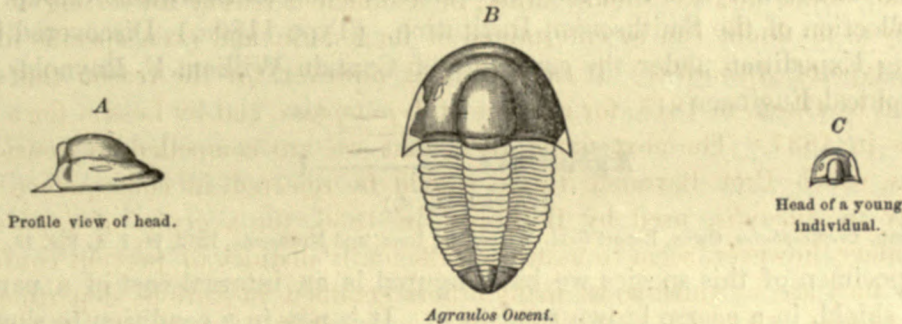
Agraulos Oweni.

Arionellus (Crepicephalus) Oweni, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila., December, 1861, p. 436.

Arionellus? Oweni, MEEK & HAYDEN, Am. Jour. Sci. Ser. XXXIII, 74, January, 1862.

Head semi-circular, or nearly semielliptic in outline, its length equalling about two-thirds its breadth, rather distinctly convex; posterior margin more or less concave in outline, and provided with a deep, rounded marginal groove along each lateral slope. Glabella oblong-subovate, rather gibbous, elevated above the cheeks and tapering towards the rounded front with slightly convex lateral margins; greatest convexity near the middle and behind; separated from the cheeks, on each side and in front, by a distinct furrow; neck furrow passing entirely across, but slightly deeper on each side than at the middle; lateral grooves three, very short, obscure, or (in casts) nearly obsolete, and but slightly oblique. Cervical segment a little convex at its posterior outline, less elevated than the glabella. Anterior slope in advance of the glabella less than half as wide as the length of the latter, and provided with a distinct, rounded transverse furrow, which passes around slightly in front of the middle of the space parallel to the anterior and antero-lateral margins. Cheeks convex, and sloping towards the lateral and antero-lateral borders. (Surface and facial sutures unknown.)

Length of cephalic shield, measuring from the posterior side of the neck segment to the front margin, 0.57 inch; greatest breadth, measuring across at the posterior extremities of the cheeks, 0.87 inch; height, 0.31 inch. Length of glabella, including the neck segment, 0.40 inch; breadth of glabella, 0.35 inch.



- A. Side view of a cephalic shield of *Agraulos Oweni*, the position of the eyes (which have not been distinctly seen) indicated by a dotted line.
- B. Another view of the same, and of a small pygidium supposed to belong to the same species, with the body restored in outline. In this cut the marginal furrow passing around the front of the head is made to terminate rather too abruptly on each side; while the lateral furrows of the glabella are indicated too distinctly. In the specimens these furrows are very obscure, and it is difficult to see whether there were only two, or more on each side.
- C. Head of a young individual, same species.

The only specimens of this species yet obtained are casts, which show no traces of the sutures, and retain no remains of surface granulations, striæ, or other markings, if there ever were any. Nor are they in a condition to show whether or not the postero-lateral extremities of the buckler are pointed, though they probably are. At a point nearly opposite the middle of the glabella, there is on each cheek, less than half way down the slope from the furrow between the fixed cheeks and the glabella, the remains of a small eye, though the specimen being unfortunately a little defective here on both sides, the exact form of these prominences cannot be clearly made out.

In the same slab containing the cephalic shield above described, we observe a pygidium which probably belongs to the same species. It is sub-semicircular in form, moderately convex, and rather distinctly, as well as nearly equally trilobate.

Its middle lobe is more prominent than the lateral, and shows three segments; the lateral lobes appear to have only two segments.

Compared with Prof. Barrande's beautiful figures of the variable typical species, *A. ceticephalus*, of its own size, the head of our species is more regularly rounded in front, and differs in having a distinct anterior marginal furrow, while its glabella is proportionally longer. A specimen of a much smaller individual in the same matrix, shows this species to have been also much less variable in the characters just mentioned, at different periods of its growth, than *A. ceticephalus*. Again, if the pygidium mentioned above belongs to the species under consideration, it was larger in proportion to the largest head we have seen, than in the European species.

Dr. Shumard and Mr. Billings, to whom we sent sketches of our species, regard it as being clearly distinct from any of the forms described by either of them from the Primordial rocks of Texas and Canada.

As the specimens of this *Trilobite* came in after our plates were made up, we could not well introduce figures of it there, but the annexed wood-cuts will give a tolerably good idea of its general appearance.

Locality and position. Near the head of Powder River, in the Big Horn Mountains, Dakota Territory. From the Primordial or Potsdam Sandstone Group. No. 1180, collection of the Smithsonian Institution. (Type 1180a.) Discovered by the Exploring Expedition under the command of Captain William F. Raynolds, U. S. Topographical Engineers.

Agraulos? ————— ?

(PLATE I, Fig. 4.)

Comp. *Crepicephalus*, OWEN, Report Geol. Wisconsin, Iowa, and Minnesota, 1852, Pl. I. A. Fig. 18.

The specimen of this species we have figured is an internal cast of a part of a cephalic shield, in a coarse brown sandstone. It is not in a condition to show any traces of the facial sutures, or even the form of the entire glabella, nor the position of the eyes, if they exist. Hence we cannot determine with much confidence to what genus it belongs, nor can we give any characters by which the species can be identified. As near as can be determined, it seems to be similar to some of the forms figured by Dr. Owen under the name *Crepicephalus*. It also resembles the foregoing species from Big Horn Mountain, and may possibly be the same. Still, as it presents some slight differences, it may prove to belong to another species. Although a mere fragment, we have thought it should be figured, since, as far as its affinities can be made out, it corroborates the evidence of the other fossils in regard to the age of the formation.

Locality and position. Central part of the Black Hills, Dakota Territory. Potsdam or Primordial Sandstone. No. 1024.

CARBONIFEROUS AGE.

(CARBONIFEROUS PERIOD.)

PROTOZOA.

CLASS RHIZOPODA.

ORDER Foraminifera.

FAMILY CAMERINIDÆ.

Shell comparatively large and dense, discoid, lenticular, fusiform, cylindrical, oval, or subglobose in outline; symmetrically involute, or rarely somewhat obliquely spiral. Last volution generally embracing all the others, so as to present, in the typical genera, the form of an *Ammonite* or *Nautilus*. Septa nearly always double, each chamber having its own walls, which, without exception, differ from the rest of the shell in being destitute of the ordinary tubular structure, so that the chambers are only connected by the principal aperture, and a few large "orbuline" pores. Canal system radiating between the double walls of the septa, generally well developed and connected with the "intermediate skeleton," secreted apparently for the consolidation of the entire structure. Aperture in the typical forms a narrow fissure placed symmetrically between the outer wall of the penultimate whorl, and the inner side of the last or outer series of chambers; sometimes partly closed by a shelly secretion so as to leave only a series of pore-like openings; in *Amphistegina* placed on the under side of the spiral plane.

In Dr. Carpenter's beautiful and elaborate Memoir on the *Foraminifera*,¹ published by the Ray Society, in 1862, the genera included in this family (there called *Nummulinida*) are the following,—in part, however, under other generic names, viz.: *Camerina*, = (*Nummulites*, Lamk.) *Amphistegina*, *Operculina*, *Elphidium*, = (*Polystomella*, Lamk.) *Heterostegina*, *Cycloclypeus*, *Orbitoides* and *Fusulina*. It includes the largest and most highly developed of the *Foraminifera*, as well as those possessing the most densely constructed shells. The living examples are mainly confined to the tropical and temperate seas, the larger types occurring in the tropics.

In regard to some of the names here adopted, a word of explanation may not be out of place. First it will be observed we use Bruguiere's name *Camerina*

¹ To which we are mainly indebted for the characters given in the above description.

instead of *Nummulites*, Lamarck, or *Nummulina*, D'Orbigny; and as this is usually considered the typical genus of the family, we have adopted the family name *Camerinidæ*, instead of *Nautiloidæ*, or *Nummulinidæ*. Our reason for restoring Bruguiere's name, is, that it has priority over all the other regularly proposed genera. It was also adopted by Cuvier, in 1798, as well as by Lamarck himself in 1799,¹ and of course previous to the publication of *Nummulites* and *Nummulina*. This will be better understood by the following glance at the history of the genus:—

Previous to the introduction of the binomial nomenclature by Linnæus, these fossils were known to the early writers by such specific phrases as "*Helicites niger foliolis candidus*," "*Pierre lenticulaire*," "*Nummi lapidi*," "*Pierres numismalis*," &c. In 1792, however, Bruguiere proposed for them the generic name *Camerina* (Encyc. Meth. I, 396), giving at the same time a tolerably good description and history of the genus, occupying three and a half of the quarto pages of the Encyclopedia, followed by descriptions of the four species—*Camerina lævigata*, *C. striata*, *C. tuberculata*, and *C. nummularia*—all of which have been recognized by the later writers as belonging to the genus subsequently named *Nummulites*, by Lamarck, and still later, *Nummulina*, by D'Orbigny. It was in his Syst. An., published in 1801, page 101, that Lamarck first proposed the name *Nummulites*, adding little or nothing to what Bruguiere had published. In 1804 (An. Mus. V, 237), he ranged Bruguiere's species under the new generic name *Nummulites*, with very nearly the same descriptions, and references to figures and descriptions of previous authors given by Bruguiere, as he did again in 1826 (An. sans Vert., VIII, 627). In 1825, D'Orbigny, supposing the genus had living representatives, gave a third name, *Nummulina*. At various times other names were proposed for this group by other authors, but as none of them antedate Bruguiere's, and they have all been dropped out of use, they have no bearing on the question of priority, and need not be cited here.

Now we cannot recognize any right or authority for the changes made by Lamarck and D'Orbigny. Surely it cannot be urged that Bruguiere's erroneous opinion in regard to the affinities of the *Foraminifera* is a reason for setting aside his name, when Lamarck and D'Orbigny also classed them with the *Mollusca*. But even if they had discovered the true affinities of the genus, or of the order to which it belongs, this would not have given them the right to change a regularly established generic name; for if we admit such a rule, there would be no end to changes, since natural history is constantly advancing, and improvements in the classification of animals and plants are continually being made, and may be expected for a long time to come, as the affinities of the various groups are better understood. Such a rule, for instance, would have given Dujardin the right to change the names of all the genera of the entire order, when he in 1825 discovered that the *Foraminifera* are not *Cephalopoda*, nor even *Mollusks* at all, but *Protozoa*.

Nor can we admit D'Orbigny's right to change Lamarck's name *Nummulites* (had it been well founded) to *Nummulina*, if he had found a living species of the genus: since it has many fossil species, and it would be an absurdity to designate the living species of a genus by one generic name, and the fossil species by another, while the name most applicable to the fossil species has priority. Does any Conchologist, for instance, think Swainson's name *Volutilithes* should be changed

¹ See Prodr. p. 80, where his only cited example is *C. lævigata*, Brug.

because a living species of that group was found at the Cape of Good Hope? Or, if a naturalist should dredge up from the bottom of some unexplored sea, a living Ammonite, would Palæontologists admit his right to change the name of the genus?

The other instance where we have restored an older name, is in adopting *Elphidium*, Montfort, instead of *Polystomella*, Lamarck, Montfort's name having been published in 1808, in his *Conchyl. Syst.*, Vol. I, pp. 14-15. It is true, not very much can be said for his figure or description, but as he refers to the figures and description of Von Fitchell and Von Moll, so that later authorities do not hesitate to identify the type of his genus with a species of *Polystomella*, Lamarck, which name was not published until 1822, we feel bound to adopt his name. The fact that he gave some five or six other generic names to other species and varieties of the same genus on subsequent pages of his work, does not alter the case, for it matters not how many names an author may give a genus, we are bound to adopt his first name, if not pre-occupied, and his type can be identified, and does not belong to a previously described genus; the subsequent names of course falling into the list of synonyms.

Genus FUSULINA, FISCHER.

Synon.—*Fusulina*, FISCHER, *Oryct. du Gov. de Moscou*, 1837, p. 126.—D'ORBIGNY, in Murchison, Verneuil & Keyserling's *Geol. Russ.* II (part iii, Pal.), 1845, p. 15.—CONR., *Element. de Geol. Strat.*, II, 1852, 169.

Borelis (sp.), EHRENBURG, *Berlin Monatsb.* 1842, 274 (not Montfort, 1808).

Etyim.—*Fusus*, a spindle.

Type.—*Fusulina cylindrica*, FISCHER.

Shell regular, equilateral; fusiform, cylindrical or subglobose, according to its greater or less elongation in the direction of the axis, sometimes constricted around the middle; symmetrically involute so that each turn envelops all the preceding at all stages of growth. Surface with nearly parallel, subequidistant furrows coincident with the septa within, and running in the direction of the axis. Aperture a narrow slit confined to the central region. Foramina passing through the external walls of the chambers, of moderate size. Septa comparatively narrow in the middle, and gradually widening towards the extremities; apparently composed each of a single lamina; regularly undulated laterally, so as to partly subdivide each intervening chamber on each side of the broad mesial avenue (connecting the different chambers) into a series of small alternately arranged cells connected together by narrow galleries. Internal canal system, and "intermediate skeleton" apparently wanting.

The shells of this genus present the various modifications of form, and much the general appearance of the genus *Alveolina*, from which, however, they can be readily distinguished by their aperture consisting of a single mesial slit, instead of a single or multiple series of round or oval openings extending along the entire length of the shell. They also differ entirely in their internal structure, the different chambers in *Fusulina* being connected with each other by the single broad mesial slit corresponding to the aperture in the last or outer septum, and not sub-

divided by revolving septa; while in *Alveolina* there is another system of subordinate septa crossing the longitudinal series at right angles, and thus forming a complex system of chamberlets connected by openings passing through the principal septa, and corresponding to the numerous apertures in the last or outer septum. The surface in *Alveolina* is also marked in addition to the longitudinal furrows, by another series of smaller revolving linear depressions, coincident with the series of secondary septa. We observe Dr. Carpenter speaks with some doubt in regard to the foramina in the walls of the shells of *Fusulina*, though he thought he had seen indications of them. On making a transverse section of one of our Kansas specimens, we were enabled to see these foramina distinctly, under a high magnifying power, by transmitted light. Fig. 6, *c*, Pl. I, illustrates their appearance. We saw no satisfactory evidences of an intermediate canal system, though some of the septa seemed to exhibit slight indications of being double.

So far as known, the genus *Fusulina* is mainly, if not entirely, peculiar to the Carboniferous System.¹ In the Old World, it seems also to occur only in the Sub-carboniferous Series, particularly in Russia. In this country, however, at any rate east of the Rocky Mountains, it has only been found in our Coal Measures. It is represented by one or more species, in great numbers, in the Coal Measures of some of the Western States, particularly in southeastern Nebraska, western Iowa, eastern Kansas, and portions of Missouri, Arkansas, Texas, Illinois, and, according to Mr. Verneuil (*Am. Jour. Sci.* (2) II, 1846, p. 293), in Ohio.

A species (*F. hyperborea*, Salter) was discovered in carboniferous rocks as high north as 76° 30', at Depot Point, Albert's Land.

Fusulina cylindrica

(PLATE I, Fig. 6, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*.)

Fusulina cylindrica, FISCHER, *Oryct. du Gouv. de Moscou*, 1837, 126, pl. xviii, fig. 1-5.

Fusulina depressa, FISCHER, *ib.*, pl. xiii, fig. 6-11.

Fusulina cylindrica, MEEK & HAYDEN, *Proceed. Acad. Nat. Sci. Phila.* December, 1858, 260.

Fusulina cylindrica, var. *ventricosa*, MEEK & HAYDEN, *ib.*, 261.

Shell fusiform, more or less ventricose in the middle, somewhat obtusely pointed at the extremities, which generally have the appearance of being a little twisted. Surface smooth excepting the septal furrows, which are moderately distinct, more or less regular, and a little curved as they approach the extremities. Aperture rather short, very narrow, and rarely visible as specimens are usually found. Volutions six to eight, closely coiled, the spaces between (near the middle) being rarely more than twice the thickness of the shell walls. Septa from twenty to about thirty-three in the last turn of adult specimens, counting around the middle; comparatively straight near their outer margins, but strongly undulated laterally within. Foramina passing through the outer walls of the chambers, distinct in well preserved specimens; as seen in transverse sections near the middle of the shell, somewhat radiating, and numbering in the outer turns of a medium sized shell, from twelve to twenty between each two of the septa.

Length (of a slender specimen), 0.37 inch; diameter, in the middle at right angles to the axis, 0.13 inch. Length (of a ventricose individual), 0.38 inch; diameter at right angles to the axis, near the middle, 0.20 inch. Types of figures and description, 1029, 1028.

The little shell described above, agrees so nearly with the figures and descriptions of *Fusulina cylindrica* of Fischer, that we are at a loss to find constant

¹ Dr. Shumard describes a gigantic species attaining a length of two inches, from rocks in Texas supposed to be of the age of the Permian System of Europe (see *Trans. St. Louis Acad. Sci.* I, 397). From the description, however, we should suspect that it may belong to an allied, but distinct genus, since the aperture is said to extend the entire length of the shell.

characters by which it can be separated from that species; at any rate by the figures and descriptions we have yet seen. Still it is not improbable that a direct comparison with specimens of the Russian species would enable us to point out characters by which they could be distinguished. At one time we supposed that some ventricose specimens found by us in Kansas, might be separated as a variety from the more common slender forms; but further comparisons have satisfied us that they cannot be regarded as a sufficiently marked variety to make it desirable to designate them by a different name, there being every gradation between these two extremes. In case they should all, however, prove to be distinct from Fischer's species, the name *ventricosa* may be retained for the American type.

Locality and position.—The species here described ranges from Ohio to Kansas and southwestern Nebraska, and south to Texas. It seems to be more common, however, west of the Mississippi than east of it, and we have no knowledge of its existence east of Ohio. *It probably occurs in western Kentucky, though we have never seen specimens of it from that State. It is common in portions of Missouri. At all the localities mentioned, it is found only in the Coal Measures.

The specimens here figured and described are from Juniata, on Kansas River, Kansas, where it occurs in great numbers.

MOLLUSCA.

CLASS BRACHIOPODA.

FAMILY SPIRIFERIDÆ.

Shell free, inequivalve, varying greatly in form and ornamentation according to the genera and species; with or without a cardinal area; oral appendages large, provided with calcified, ribbon-shaped supports, which are spirally coiled so as to form two cones, the apices of which are directed outwards towards the lateral margins of the valves. Shell structure fibrous only, or fibro-punctate.

Animal unknown, apparently sometimes attached by a muscular peduncle.

Palæontologists generally place in this family all the Brachiopods known to possess calcified spiral oral appendages, however these appendages may be arranged or attached. We agree with Mr. Woodward and some others, however, in separating from it the genus *Atrypa*, which differs from the other genera usually placed in this family, in having the cones formed by its spiral oral appendages placed with their apices directed vertically instead of laterally, thus apparently indicating affinities to the *Rhynchonellidæ* (probably also including *Stenocisma*¹ and *Cælospira*), in which the fleshy oral arms are similarly arranged.

The great differences of form and other characters presented by the other genera usually embraced in this family, render it also highly probable that they belong to more than one family; but as we can scarcely ever hope to know enough of the affinities of these extinct genera to successfully separate them, it is not probable that any attempt of that kind would meet with much favor. The entire family is, so far as known, extinct, and none of the genera appear to range above the Lias.

The groups falling within this family, as here defined, are *Trigonotreta*, *Martinia*, *Spirifina*, *Spirifer*, *Syringothyris*, *Cyrtina*, *Suessia*, *Trematospira*, *Spirigera*, *Merista*, *Pentagonia*,² *Nucleospira*, *Uncites*, *Retzia*, *Rhynchospira*, *Acambonia*, &c.

¹ In the Fifteenth Report Regents University of N. Y., 1862, p. 154-5, Prof. Hall proposes the name *Zygospira* for a genus of which *Producta modesta*, Say, is the type. It seems, however, that Mr. Conrad had suggested for this shell the generic name *Stenocisma*; which Prof. Hall proposed in the first Vol. Pal. N. Y. (1847, p. 142) to adopt, should this type prove to belong to a distinct genus. As there was, therefore, no necessity for a new name, *Stenocisma* will have to take precedence over *Zygospira*.

² The name *Pentagonia* was proposed by Cozzens, in 1846 (Ann. Lyc. N. Hist., N. Y., IV, p. 158), for a genus, or subgenus of peculiar angular Meristoid shells, of which *Pentagonia unisulcata* (= *Atrypa unisulcata*, Conrad, = *Pentagonia Persii*, Cozzens, = *Meristella* (*Goniocælia*) *unisulcata*, Hall) is the type. In 1861, Prof. Hall suggests the name *Goniocælia* for the same type (Fourteenth Rept. Regents University of N. Y., p. 101). Cozzens' name having priority, however, must be adopted for the group, whether we consider it a genus or a subgenus.

Genus SPIRIFER, SOWERBY.

Synon.—*Hysterolites*, *Anomites* and *Terebratulites* (part) of early authors.

Terebratula (part), LAMARCK, Prodr. 1799, 85 (not of authors generally).

Spirifer, SOWERBY, Min. Conch. II, 1815, 42.

Trigonotreta, KÖNIG, Icon. Sect. No. 70, 1825.—BRONN, Leth. Geog. 1837, 77.—KING (part), Monog. Perm. Foss. England, 1850, 126.

Choristites, FISCHER, Prodr. sur le Choristites Mosc. 1825, xx.

Delthyris, DALMAN, Kongl. Vet. Ac. Handl. 1827.

Cyrtia, DALMAN, ib., 1827.

Spirifera, SOWERBY, Ind. to Min. Con. 1825; and of several later authors.

Martinia, MCCOY, Synop. Carb. Foss. Ireland, 1844, 139.

Reticularia (part), MCCOY, ib., 142.

Brachythyris, MCCOY, ib., 144.

Ambocalia, HALL, Thirteenth An. Rept. Regents University of N. Y., 1860, 71.

Etymol.—*Spira*, a spire; *fero*, to bear.

Type.—*Spirifer cuspidatus*, SOWERBY.

Shell more or less triangular, semicircular, transversely elongate, or subglobose, with or without a mesial fold and sinus; lateral margins rounded, angular, or sometimes produced into mucronate, wing-like extensions; structure impunctate; surface plicate, costate, striate or smooth—sometimes roughened by minute granular or spinous projections. Cardinal line straight, as long as, or shorter than, the greatest transverse diameter of the valves. Hinge articulated by short teeth and sockets, and provided with a more or less developed cardinal area in each valve; that of the ventral valve being larger than the other, flat or arched, and generally inclined back over the hinge—divided by a triangular foramen usually more or less (sometimes entirely) closed by a false deltidium, which is occasionally pierced by a small circular or oval aperture near the beak; area of dorsal or smaller valve narrow, often linear, divided in the middle by a wide open fissure which is partly or entirely occupied by the cardinal muscular process. Beak of ventral or larger valve more prominent than that of the other, incurved or more or less nearly straight, that of the smaller valve short, and nearly always incurved.

In the interior of the dorsal valve the large spiral supports of the labial arms are attached by their crura to the hinge plates, some distance from which they are nearly or quite connected by a small process extending inwards from each. The cardinal muscles seem to have been attached to the cardinal process, under, and in front of which, the four large scars of the adductor muscles occur. In the larger or ventral valve the cardinal teeth are placed one on each side, and at the base of the foramen, and fit into corresponding sockets in the other valve; beneath the hinge these teeth are supported by the strong dental laminae, which vary much in size and form, according to the species, and are supposed to have received on their inner sides the muscles of the peduncle. A considerable portion of the central region of this valve is occupied by the muscular scars, which are generally divided by a mesial ridge. Immediately on each side of this ridge occur the small longi-

tudinally oval scars of the adductors, and outside of these the scars left by the cardinal muscles.

Some difference of opinion exists in regard to the particular species that should be considered the type of this genus. Most authors have fallen into the habit of viewing *Spirifer striatus* as the type, mainly, we believe, because Sowerby first discovered internal spiral appendages in that species, and had announced this discovery before the Linnæan Society in a paper read in 1814, but not published until during the following year, about the time the second volume of his Mineral Conchology, containing his description of the genus *Spirifer*, issued from the press. It is worthy of note, however, that he does not propose, in this paper, to establish a new genus upon *Spirifer striatus*—(which he there designates by the old name *Anomia striata*)—nor upon any other species, though he does allude to *Spirifer cuspidatus*, in a foot-note, appended some time between the reading and publication of the paper, as being figured in his Mineral Conchology as "*Spirifer cuspidatus*." So that even admitting that this paper was distributed a few months earlier than the second volume of his Mineral Conchology, *Spirifer cuspidatus* would still be the first species in connection with which we have any evidence he ever used the name *Spirifer*. It is also the first and *only* species described by him at the time that he founded the genus in the second volume of his Mineral Conchology, while he there makes no allusion whatever to the species *striatus*. It has been objected, however, that he admits in his remarks after the description of *S. cuspidatus*, immediately following the description of the genus *Spirifer*, that he only inferred from analogy, that this species possessed internal spires. In this inference, however, later discoveries show that he was correct; so that the name *Spirifer*, as well as all the characters mentioned in his description of the genus, are as applicable to *S. cuspidatus*, as to the species *striatus*. Hence we think that in accordance with the laws of priority *S. cuspidatus* should be regarded as the type of the genus.

We are not, however, in favor of so rigidly carrying out this rule as to invariably, and under all circumstances, regard the first species mentioned or described in connection with a new generic name, as its type, especially when that particular species may happen to present some important characters directly opposed to those given in the generic description, while another species described at the same time *does* exhibit these particular characters. But when an author describes a new genus, and at the same time describes but a single species, which presents all the characters given in the description, although he may have only inferred from analogy that it possessed some particular one of those characters he had not seen, we are compelled to regard that species as the type of the genus. The fact that he may have at some previous time seen this character in another form subsequently referred by him in another volume to the same genus, as Sowerby did with *Spirifer striatus*, cannot, we should think, invalidate the claims of the first species (*S. cuspidatus*) to be regarded as the type.

If we are right in these conclusions, Dalman's name *Cyrtia* becomes exactly synonymous with the genus *Spirifer*, since it was founded for the reception of species possessing precisely the characters of the typical forms of that genus; while the species usually viewed as typical Spirifers, must form a distinct sub-generic or

generic group, to which Kœnig gave the name *Trigonotreta*, subsequently adopted by Prof. Bronn, and by Prof. King.¹

As here defined and typified, it will be seen that this genus includes two rather marked sections, with one or more less distinctly defined groups, which may be characterized as follows:—

1. *Spirifer* (proper), SOWERBY, = *Cyrtia*, DALMAN, and others.

Shell trigonal, nearly always costate or striate; hinge generally a little less than the breadth of the valves, more or less angular at the extremities; ventral valve very prominent or pyramidal; beak straight or a little curved; area large and triangular; foramen closed by a false deltidium, generally pierced by a small round or oval aperture near the apex of the beak; dorsal valve comparatively compressed, semicircular.

2. *Trigonotreta*, KœNIG, = *Spirifer*, of most authors.

Shell usually with both valves convex, marked as in the foregoing; lateral extremities generally angular, often acutely so; hinge line usually extended. Both valves with beaks more or less incurved; area variable in size, but rarely if ever so extravagantly developed as in some of the typical *Spirifers*; foramen open or more or less closed by a false deltidium without a perforation.

Example.—*Spirifer striatus*, SOWERBY.

3. *Martinia*, MCCOY, = *Ambocalia*, HALL.

Shell subglobose, or transversely or longitudinally oval, smooth or rarely with compressed rounded costæ; often beset with minute hair-like spines. Hinge short, scarcely ever equalling the greatest transverse diameter of the valves; lateral margins rounded, or rarely obtusely angular; beak of ventral valve incurved; cardinal area comparatively small; foramen, and false deltidium as in *Trigonotreta*.

Type.—*Spirifer glaber*, SOWERBY.

The genus *Spiriferina* of D'Orbigny, is also often considered a subgenus under *Spirifer*. The coincidence, however, of a punctate structure in these shells, with the presence of a prominent mesial septum in the ventral valve, would seem to indicate important differences in the structure of the animal, such as would warrant its separation as a distinct genus.² So also with *Cyrtina* of Davidson, which was formerly included with the forms we here regard as the typical *Spirifers*, under the name *Cyrtia*. Mr. Davidson has, however, very properly separated these shells, on account of their punctate structure, and the peculiar development of the dental laminae of the ventral valve, which are produced inwards, and coalesce into a single mesial septum, extending from the extremity of the beak, almost to the anterior margin, thus giving the interior more the appearance of *Pentamerus* than *Spirifer*. As Mr. Billings has, however, discovered internal spiral appendages in one of these shells, and they all possess a well-developed cardinal area, we cannot doubt the propriety of including them in the *Spiriferidæ*, though we think, as above stated, that they should constitute a distinct genus from all the other groups.

As thus freed from the punctate species, the typical *Spirifers* (= *Cyrtia*, Dalman) are found to pass by such insensible gradations into the *Trigonotreta* group (= the

¹ In his valuable work on the Permian fossils of England, Prof. King regarded *Spirifer cuspidatus* as the type of the genus, and adopted Kœnig's name *Trigonotreta* for the shells generally considered typical *Spirifers*. It is said, however, that he subsequently changed his views in regard to the type of *Spirifer*.

² I avail myself of this opportunity to refer to the genus *Spiriferina*, a species described by me under the name of *Spirifera pulchra* (Proceed. Acad. Nat. Sci. July, 1860, p. 310), brought by Capt. Simpson from Nevada Territory. Sections of it show very distinctly a coarsely punctate, very finely fibrous structure; while casts of the interior exhibit a deep slit left by the mesial septum in the beak of the ventral valve—F. B. M.

usual type of *Spirifer* as generally understood), that we cannot see how the two can be separated more than as sections or subgenera.

It will therefore be seen, that in our present state of knowledge, it seems to be most natural to exclude entirely from the genus *Spirifer*, all the punctate species. Entertaining these views, it becomes necessary for us to explain why we have placed *Ambocælia*, which has been described as "fibrous (or fibro-punctate)" with "lustre pearly," as a synonym of *Martinia*, one of the sections of *Spirifer*.

Our reasons are, in the first place, that we see nothing in the form and external appearances of the type of this proposed genus, to separate it from *Martinia*; especially since the closely allied *Ambocælia gemmula*, of McChesney, which was also included by the author of *Ambocælia* in that group, sometimes has its dorsal valve a little convex—indeed occasionally as much so as the scarcely distinguishable European *Spirifer Urei* and *S. Clanyanus*—though it is more frequently flat or concave as in the type of *Ambocælia*. Again, we know from an examination of New York specimens of the type of *Ambocælia*, in the collection of Mr. Worthen, State Geologist of Illinois, that it has internal spires arranged as in *Spirifer*. Thinking, however, that the punctate structure, and the supposed pearly lustre of this type, might warrant its separation, we subjected authentic specimens of it from the Hamilton Group, New York, to a careful microscopical examination, both in polished sections, and in thin broken fragments, and although we could distinctly see the usual fibrous structure so generally characteristic of the *Brachiopoda*, we failed to detect any traces of perforations, even by the aid of a high magnifying power.

In regard to the lustre, we think the word "pearly" must have been inadvertently written, or wrongly printed, for although fractured surfaces of this shell present a shining, somewhat silvery appearance, not unusual in the shells of fossil *Brachiopoda*, it cannot be said to be *pearly*, as that term is usually understood by Conchologists.

From these facts we do not feel prepared to admit *Ambocælia* even as a distinct section from *Martinia*, until some more reliable differences can be pointed out.

The genus *Spirifer*, as here characterized, commenced its existence during the Lower Silurian epoch, and ranges through the more modern formations into the Triassic rocks.

***Spirifer* (*Martinia*) *plano-convexus*.**

Spirifer plano-convexus, SHUMARD, Report Geol. Survey Missouri, 1855, part Palæontology, 202.

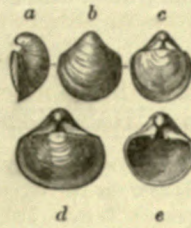
Ambocælia gemmula, MCCHESENEY, New Palæozoic Fossils, 1860, 41.

Ambocælia gemmula, HALL, Thirteenth Report Regents University, N. Y. 1860, 71.

Comp. *Sp. Urei*, FLEMING, Brit. Animals, 1828, 376.

Shell small, plano-convex or coneavo-convex, young individuals usually longer than wide, adults wider than long; hinge line always shorter than the greatest transverse diameter of the valves; lateral margins and front rounded; surface apparently smooth excepting a few concentric marks of growth—but when examined with a magnifier, it is sometimes seen to be beset with the bases of minute hair-like spinules. Dorsal or smaller valve slightly convex near the beak, but usually concave around the front and antero-lateral margins, especially in adult individuals; truncato-orbicular in outline, usually very faintly depressed at the middle of the front; beak very small, not incurved, nor projecting beyond the cardinal margin; area about half as wide as in the other valve, flat, and standing nearly at right angles to the plane of the valve; foramen extending to the beak. Ventral valve strongly convex, sometimes very faintly flattened along the middle, but without a mesial sinus; beak very prominent, gibbous, and distinctly arched back over the hinge; area moderate, triangular, arched, well defined, and generally longer on the hinge side than the lateral margins; foramen usually higher than wide, provided with slightly raised lateral margins, not closed (so far as known) by a pseudo-deltidium. (Muscular impressions unknown.) Spiral appendages each consisting of six or seven distant turns.

Length of a large individual, 0.31 inch; breadth, 0.36 inch; convexity, 0.23 inch. Length of a young shell, 0.27 inch; breadth, 0.23 inch; convexity, 0.15 inch.



Spirifer (Martina) plano-convexus.

a. Side view of medium sized specimen. *b.* Ventral view of same. *c.* Dorsal view of same. *d.* Dorsal view of a larger transverse specimen, showing the area and foramen. *e.* Hinge and internal view of a separated ventral.

This little shell seems to agree exactly with the species described by Dr. Shumard under the name *Spirifer plano-convexus*, and by Mr. McChesney, as *S. gemmula*, excepting that none of the (twenty or thirty) specimens we have seen show the faint mesial depression or sinus in the ventral or larger valve, mentioned by these gentlemen. As some of them, however, show a very slight flattening of the middle of this valve, it is probable other individuals may possess an obscure narrow sinus. It is worthy of note that the descriptions given by these gentlemen agree quite as well with the European *S. Urei*, and we are strongly inclined to the opinion that the form described by them, as well as that now before us, really belongs to that well known species. Still, as our specimens nearly all differ from all the figures of that species we have seen, in having the smaller valve, especially in adult examples, a little concave, and the ventral valve destitute of a mesial sinus, while they attain a much larger size, we have concluded to place them provisionally under Dr. Shumard's name *plano-convexus*.¹

As the closely allied *Spirifer (Martina) umbonatus* (= *Orthis umbonata*, Conr.), for which the new generic name *Ambocælia* has been proposed, is described as having a "fibro-punctate" structure, we examined the structure of the species under consideration very carefully, by transmitted light under a high magnifying power, to see if we could detect the presence of punctures; but after repeated trials we failed to observe any traces of them, though we saw distinctly the usual fibro-prismatic structure.

Locality and position.—Manhattan, on Kansas River; Upper Mill Creek, and at various other localities in Eastern Kansas. Coal Measures. (Type of description and figures, 996, *a, b, c.*)

FAMILY PRODUCTIDÆ.

Shell free or attached by the substance of the beak, concavo-convex; valves articulated by teeth and sockets, or retained in place by the action of muscles only; hinge with or without a cardinal area; oral appendages without calcified supports, and probably fleshy and spiral; surface more or less spinous; substance fibro-punctate.

Animal unknown.

¹ Since this was in type we have received a letter from Dr. Shumard, to whom we had sent the cuts of this species, in which he says he has no doubt of its identity with his *S. plano-convexus*.

This family includes the genera *Productus*, *Strophalosia*, *Aulosteges*, and *Chonetes*. It commences in the Silurian rocks, and ends with the Permian, being a strictly Palæozoic group.

Genus CHONETES, FISCHER.

Synon.—*Pectenites*, *Pectunculites*, and *Pectunculus* (sp.) of the early authors.

Pecten, URE, Hist. Ruthenglen, 1793, pl. xvi, fig. 10-11 (not Müller, 1776).

Hysterolites and *Terebratulites* (sp.), SCHLOTH. Petref. 1820, 256, pl. xxix, fig. 3.

Productus (sp.), J. de C. SOWERBY, Min. Conch. IV, 1823 (not 1815).—BUCH (sp.), Abh. der K. Akad. Wiss. 1841, 33.

Leptæna (sp.), GOLDF. Germ. Tr. de la Beche's Geol. 1832, 523 (not Dalm., 1828.)

Chonetes, FISCHER DE WALD. Orykt. Moscon, 1837, 134.—KONINCK, An. Foss. 1843, p. 206.; Id., Monogr. Mémoires Soc. Liege IV, 1847, 1.—GEINITZ, Grundr. der Verstein. 1846, 517.—HALL, Palæont. N. Y., II, 1852, 64.

Strophomena (sp.), HALL, Geol. 4th Distr. N. Y. 1843, 72 and 180.

Etym.—*χώνη*, a little box.

Examp.—*Chonetes Dalmaniana*, DE KONINCK.

Animal unknown. Shell transversely semicircular, concavo-convex, compressed, greatest breadth usually on the hinge line; area common to both valves. Ventral valve convex, usually depressed along the hinge; area generally broader than that of the other valve, and inclined more or less back over the hinge—angular and armed along the margin with a row of tubular spines; foramen partly or entirely closed by a false deltidium. Dorsal valve concave; foramen replaced by a prominent bifid or trifid cardinal process. Surface of both valves sometimes nearly smooth, but generally ornamented by concentric marks of growth, and fine radiating striæ, or rarely large plications.

Hinge with two cardinal teeth, located one on each side of the foramen of the ventral valve, and fitting into corresponding pits in the other. Interior of both valves provided with a narrow more or less distinct mesial ridge, extending at right angles from the hinge, part of the way across, between the muscular impressions. Scars of the cardinal muscles in the ventral valve, ovate and somewhat oblique; those of the adductors very small, and placed between the impressions of the cardinal muscles and the mesial ridge. Dorsal valve with four small adductor muscular impressions, and two short linear hook-shaped vascular scars. Interior of both valves more or less granulated.

This genus was introduced during the Lower Silurian Epoch, and continued its existence at least to the close of the Carboniferous, in which it attained its maximum development.

Chonetes mucronata.

(PLATE I, Fig. 5, a, b, c, d, e.)

Chonetes mucronata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. 1858, 262.

Compare *C. Smithii*, NORWOOD & PRATTEN, Jour. Acad. Nat. Sci. Phila. 1857, 24, pl. ii, fig. 2.

Shell rather large, compressed, semicircular, having its greatest breadth on the cardinal border, which is extended into mucronate angles. Surface ornamented by a few subimbricating concentric marks of growth, crossed by very

fine, obscure, regular, closely set radiating striæ, about one hundred and fifty of which may be counted around the border of large specimens, where eight or nine of them occupy the space of one line.

Larger or dental valve depressed, having usually a broad, very shallow undefined mesial depression extending from the front towards the beak; cardinal margin armed with from eight to twelve oblique spines on each side of the beak; area of moderate breadth; deltoid aperture very broad subtriangular, the upper angle being rounded and the margins more or less projecting; impressions of cardinal muscle subovate, diverging, attenuate above; adductor muscular scars small, narrow, subelliptical; mesial ridge small, slightly prominent, and scarcely ever reaching the middle of the valve.

Dorsal or smaller valve following nearly the curve of the other; beak and central region concave; ears flat; area well developed but narrower than that of the other valve, provided with mesial prominence, which, together with the small bifid cardinal process projecting from its inner side, nearly or quite closes the foramen of the opposite valve. From the base of this process there are extending on the inside of the valve five radiating ridges, two of which pass obliquely outwards along the inner margins of the dental pits, while a third extends at right angles to the hinge a little more than half way across towards the front of the valve; the other two ridges are much shorter and occupy intermediate positions between the central and lateral ridges, and are directed obliquely outward and forward. Interior of both valves more or less granulose, the larger granules being arranged over a semicircular belt a little within the border, which latter is occupied by very fine radiating granulose striæ.

Length, 0.62 inch; breadth on hinge line, 1.13 inch.

This shell is very closely allied to *Chonetes Smithii* of Norwood & Pratten, and may possibly prove to be only a variety of that species. It differs, however, in being generally much larger, rather more compressed, and proportionally longer on the hinge line; its ears are also often much more extended and pointed than those of *C. Smithii*. Another difference is that the coarser granules of the interior seem never to be scattered over the central region of the valves as in Norwood & Pratten's species. Again, the area of its smaller valve ranges more nearly at right angles to the plane of the shell than in Illinois species.

Locality and position.—Near Fort Riley, Kansas Territory. Coal Measures. (Type 1066.)

FAMILY STROPHOMENIDÆ.

Shell attached or free; valves both convex, or one convex and the other flat or concave; hinge line straight, and provided with an area, which is common to both valves, but usually wider in the ventral than the dorsal valve; arms without calcified supports, being probably fleshy and spirally coiled; shell structure fibrous only, or fibro-punctate.

Animal unknown.

This family includes *Orthis*, *Hemipronites*, *Klitambonites*, *Strophomena*, *Leptaena* and *Tropidoleptus*. Some authors also include in it the genera *Chonetes* and *Porambonites*, but, as Mr. Davidson has demonstrated, the former belongs to the *Productidæ*; while the affinities of the latter remain somewhat doubtful.

This group presents one of the many interesting examples in the fossil world, of an entire family, embracing several genera, and a great number of species, which, after existing for immense periods of time, became entirely extinct, long before the dawn of the present epoch. It is mainly a Palæozoic family, since it appeared almost with the beginning of life, and became wholly extinct at the close of the Permian period, excepting the genus *Leptaena*, which continued to be represented by a few species until about the close of the Liassic period.

Genus HEMIPRONITES, PANDER.

Synon.—*Terebratulites* (sp.), SCHLOT. Akad. Münch., VI, 1816, 28.

Hemipronites, PANDER, Beitr. zur Geol. Russ. 1830, 75.

Klitambonites (part), PANDER, 1830, Ib., 70.

Gonambonites, PANDER, Ib., 1830, 77.

Spirifer (sp.), PHILLIPS, Geol. York. 1836, II (not SOWERBY, 1815).

Leptena (sp.), J. DE C. SOWERBY, Min. Conch. 1840 (not DALMAN, 1828).

Orthis (sp.), PORTLOCK, Rept. Geol. Lond. 1843, 456.—KONINCK. An. Foss. Belg. 1843, 222.—HALL, Geol. Rept. I wa, I part ii, 1858, 640 and 713 (not DALMAN 1828).

Orthisina (part), D'ORBIGNY, Compt. Rend. XXV, 1847, 267.—DAVIDSON, Brit. Foss. Brach. I, Gen. Introduct. 1854, 104. *Orthisina* (sp.), SWALLOW, Trans. St. Louis Acad. Sci. I, 1858, 219.—MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 260.—HALL, Thirteenth Rept. Regents University N. Y. 1860 (not D'ORBIGNY, 1849).

Hemipronites, AGASSIZ, Nom. Zool. Mol. 1846, 41.

Streptorhynchus, KING, Permian Foss. England, 1850, 107.—DAVIDSON, Brit. Permian Brachiopoda, 1857, 29.—HALL, Thirteenth Report Regents University N. Y., 1860, 112; also Sixteenth Rept. Dec. 1863, 61.

Ety.—ἡμι, half; πρῶν, prominence.

Type.—*Hemipronites tumidus*, PANDER.

Shell varying from truncato-orbicular to semicircular, or orbicular subquadrate, more or less convex, the inequality of the valves varying greatly with the species; surface marked with radiating, generally straight striæ, and sometimes with rounded radiating plications. Hinge usually shorter than the greatest breadth of the valves; provided in the ventral or larger valve with two teeth, situated one on each side of the mesial fissure, and fitting into corresponding sockets in the other valve. Structure probably always impunctate.

Ventral valve with its beak more prominent than that of the dorsal, often bent or twisted, but not regularly incurved; area generally high, sometimes extremely so, its mesial fissure always closed, in adult shells, by a convex pseudo-deltidium. Hinge teeth supported within by two dental plates, which converge under the area towards the beak. Scars of cardinal and adductor muscles occupying about one-third to one-half the length of the valve (between the beak and the middle), and forming two elongated oval impressions, more or less deeply excavated, one on each side of a mesial ridge or septum.

Dorsal valve generally with its beak compressed and projecting little beyond the cardinal margin; area usually very narrow or rudimentary. Cardinal process large, prominent, and bifid; either slightly convex or concave on the inner side, with each division more or less grooved or emarginate at the extremity of the outer side; on each side of, and connecting with this, are the well-developed socket plates. At the bottom of the valve the quadruple scars of adductor muscles occupy about one-third the length of the valve, being arranged in pairs on each side of a short mesial ridge.

The shells belonging to this group, although usually regarded as constituting a section or subgenus of *Orthis*, present sufficiently marked differences to rank as a distinct genus. In the first place they differ in having the foramen always

closed by a false deltidium, instead of being open, and hence they could scarcely have been attached by a peduncle, unless it may have been during the early stages of growth. Again, they have the beak of the ventral valve often much more produced, and more or less twisted or distorted as if from having been attached by the substance of the shell. They also have the dental laminae of the ventral valve less prominent, and converging under the area towards the beak, instead of extending farther within the valve. The cardinal process of the other valve is likewise more developed, and the inner socket walls much less so. A still more important difference, if it should prove to be constant, as seems to be the case, is the merely fibrous shell structure in this group, and the fibro-punctate structure in *Orthis*.

This genus has also been confounded with *Klitambonites*, Pander (= *Orthisina*, D'Orb.), but Mr. Davidson has shown these two groups to be distinguished by well defined external and internal characters. For instance, in *Klitambonites* there is a well developed area, provided with a covered fissure in each valve; while in *Hemipronites* (= *Streptorhynchus*) the area of the dorsal valve is generally narrow or merely rudimentary. Again, in *Klitambonites* the false deltidium covering the fissure of the larger or ventral valve is pierced near the beak by a rounded or oval aperture never seen in *Hemipronites*. The beak of the ventral valve of *Klitambonites* likewise differs in never being twisted, as we often see in *Hemipronites*, and its area is generally more inclined towards the front of the shell. In the former group the cardinal process also differs in being formed of a single projection, with two small lateral depressions, and is covered by the false deltidium; while in *Hemipronites* this process is bilobate and exposed. These groups are likewise distinguished by differences in the details of the muscular impressions.

There are a few peculiar plicated shells, with a more or less distorted beak and a high triangular area provided with a closed fissure, found in the Coal Measures of Kansas and New Mexico, which appear to form a section of this group, though they may be generically distinct. *Orthisina missouriana* and *O. Shumardiana*, of Swallow—as well as *Streptorhynchus occidentalis* and *S. pyramidalis* of Newberry, are American examples of this type. *Productus eximius* of Eichwald, from the Carboniferous rocks of Russia, and *Streptorhynchus pectiniformis*, Davidson, from India, also belong to this plicated section.

This genus was first made known by Pander, in 1830, in the work cited in the synonymy at the head of this description, under the name *Klitambonites*. He included, however, under this name, two groups regarded by him as subgenerically distinct, the first of which he called *Pronites*, and the second *Hemipronites*. The typical species of his group *Pronites* (*P. adscendens*, Pander) being also the type of the including genus *Klitambonites*, the name *Pronites* must be regarded as merely a synonym of *Klitambonites*, since it would be an absurdity to retain a separate subgeneric name for the typical species of the including genus. In addition to this, the name *Pronites* had been used in 1811 for a genus of birds by Illiger.

The species *adscendens*, the type of *Klitambonites*, presents all the generic characters of the group to which D'Orbigny subsequently gave the name *Orthisina*; while the typical species of the other supposed subgenus, *Hemipronites* (*H. tumidus*,

Pander), is a true *Streptorhynchus* of King. Now, as these two names of Pander's clearly antedate those proposed by D'Orbigny and Prof. King, and there can be no doubt in regard to the types of Pander's groups, the law of priority compels us to adopt his names. The fact that he did not clearly define his genera, and proposed many species based upon mere varieties or individual modifications of a few species, is no reason for setting aside his generic names, when his figures and descriptions leave no doubts in regard to the genera to which his types belong.

The genus *Hemipronites* was first introduced during the deposition of the *Silurian* rocks; *H. deformis* (= *Orthis deformis*, Hall, Pal. N. Y., Vol. III, p. 174, pl. xiii, 3 a, b) and *H. Woolworthanus* (= *Strophomena Woolworthana*, Hall, ib., p. 192), from the Lower Helderburg rocks of N. Y., being *Silurian* examples of this group. The genus also occurs in the *Devonian*, *Carboniferous* and *Permian* rocks, probably attaining its maximum development in the *Carboniferous*. It seems to have become extinct before the commencement of the *Triassic* period, as we have no well authenticated knowledge of its existence in beds of that age.

Hemipronites arctistriatus, *H. alternatus* (= *Orthisina arctistriata*, and *O. alternata*, Hall, Thirteenth An. Rept. Regents University, N. Y., Dec. 1860, p. 80 and 81)¹ and *H. proximus* (= *Hipparionyx proximus*, Vanuxem, Rept. 3d Geol. Dist. N. Y., 1842, p. 124) are American examples of this genus from *Devonian* deposits.

Hemipronites crassus.

(PLATE I, Fig. 7, a, b, c, d.)

Orthisina crassa, MEEK & HAYDEN, Dec. 1858, Proceed. Acad. Nat. Sci. Phila. 260.

Shell of medium size, subquadrate, rather compressed, becoming thickened with age; hinge nearly or quite equaling the greatest breadth of the shell; front broadly rounded; lateral margins meeting the hinge nearly at right angles, sometimes slightly sinuous near the hinge. Surface ornamented by numerous straight radiating striæ, which number near the beaks some thirty or forty to each valve, but increase by the implantation of others between, so as to form one hundred to one hundred and twenty-four around the margin; crossing these striæ are numerous fine elevated concentric lines, which are not only quite distinct in the depressions, but on well preserved specimens are prominent upon the striæ, to which they impart a crenulated appearance, as seen by the aid of a lens. Adult specimens generally have also several strong concentric imbricating marks of growth.

Larger or ventral valve nearly flat; cardinal edge sloping a little to the lateral margins; beak somewhat prominent, and often distorted, or slightly twisted to one side; area flat, rather broad, and usually inclined backwards over the hinge—angular along its margins; pseudo-deltidium thick, prominent, nearly or quite closing the foramen; cardinal teeth not very prominent; scars of the adductor muscles large, separated by a sharp, rather prominent mesial ridge, and in old shells deep and well defined.

Dorsal valve moderately convex in the middle, and flat or concave on each side of the slightly convex umbo; cardinal process rather narrow. Interior of both valves marked by radiating striæ around the borders.

Length of a rather large specimen, 1.25 inch; breadth, 1.30 inch; convexity of the two valves, 0.46 inch.

At the time we first described this as a new species we had not seen accurate figures of several analogous European forms now regarded as varieties of *H. crenistria* (= *Spirifer crenistria* of Phillips). Since seeing Mr. Davidson's excellent figures and descriptions of the various forms now included by him under that name, we are led to doubt whether our shell is entitled to rank as a distinct species. Indeed, supposing *H. crenistria* to vary to the extent admitted, it would seem to be impossible to assign any very definite limits to such a protean species, and hence it

¹ Prof. Hall subsequently, in a foot-note on p. 112 of the same Report, refers these species to *Streptorhynchus*.

would probably include our shell—which agrees very closely in form and surface-markings with some of those figured by Mr. Davidson. In form it seems to be most nearly allied to the species or variety *radialis* of Phillips, but differs in having its striae of nearly uniform size. Internally it also differs from that and all the other analogous species or varieties, of which we have seen figures, in having the cardinal process of the dorsal valve proportionally narrower, and the socket plates less widely divergent. The muscular and visceral impressions of its ventral valve, as may be seen by our figures, occupy a proportionally larger space, extending out as they do about half the distance from the hinge to the front; while in the forms figured by Mr. Davidson, they only extend about one-third of the distance from the hinge to the front. These differences, however, may not be of specific value.

Locality and position.—Leavenworth City, Kansas, from a bed nearly on a level with the Missouri River. Coal Measures. (No. 1010.)

CLASS LAMELLIBRANCHIATA.

FAMILY PTERIIDÆ.

(= AVICULIDÆ.)

Shell inequivalve, inequilateral, composed of an inner laminated pearly layer, and an outer prismatic substance; left or upper valve always more convex than the other. Anterior margin of the right valve generally more or less sinuous for the passage of the byssus. Cartilage submarginal, simple, and placed in a single cavity or depression near the beaks, or divided and distributed in a series of furrows crossing the cardinal facet at right angles—or, in some of the older fossil genera (if distinct at all from the ligament), occupying linear furrows in the cardinal area or facet, ranging more or less nearly parallel to the hinge line. Hinge with or without teeth. Scar of adductor muscle large and usually sub-central; anterior muscular impression generally small and placed near the beaks, sometimes moderately developed. Pallial line simple, often irregularly dotted.

Animal, in the existing typical genus, with mantle margin freely open and doubly fringed; foot small, grooved, and having the power of spinning a byssus; palpi large; gills two on each side, crescent-shaped, free or connected with each other posteriorly, and to the mantle.

The above diagnosis is drawn up so as to include species belonging to three subordinate groups, the first of which, so far as known, has no living representatives, and seems to be mainly confined to the Palæozoic rocks. The other two groups (the *Pteriinae* or *Aviculinae*, and *Melininae*) are both represented by living species in our existing seas. These three sections or subfamilies may be characterized as follows:—

1. Pteriniinæ (or *Pterinia* group).

Cartilage apparently occupying a series of linear furrows, ranging more or less nearly parallel to the cardinal margin, in a usually broad, flattened cardinal facet or area. Anterior muscular scar sometimes moderately developed and deep.

Includes *Pterinia*, *Myalina*, *Ambonychia*, and probably *Actinodesma*, *Gryphorhynchus*,¹ *Eurydesma*, and several undefined Palæozoic groups. A part of the species referred to the genus *Megambonia* (*M. aviculoides*, *M. lamellosa*, &c., HALL), will probably be found to belong to this subfamily, if not indeed to the genus *Pterinia*, while the typical species appear to belong to the family *Arcidæ*.

2. Pterinæ (or *Aviculinæ*).

Cartilage mainly or entirely confined to a single more or less defined depression or cavity behind the beaks. Anterior muscular impression very small.

Includes *Pteroperna*, *Pteria* (or *Avicula*), *Margaritifera*, *Malleus*, *Aucella* and *Eumicrotis*.² The following extinct genera also probably belong here, viz.: *Monotis*, *Halobia*, *Pteronites* and *Possidonomia*, with apparently some undescribed fossil genera.

3. Melininæ (*Perna* or *Isognomon* group).

Cartilage divided and distributed along the hinge in a series of furrows crossing the cardinal area at right angles to the hinge line. Anterior muscular scar generally very small.

Includes *Crenatula*, *Melina* (= *Perna*, BRUG. not ADANSON), *Bakevellia*, *Gervillia*, *Inoceramus* and *Pulvinites*.

The first two of these sections seem to be more nearly related, in some respects, to each other, than either is to the third; and it is not improbable that they will be found connected by a few Triassic and Jurassic forms presenting intermediate characters, when the hinge and interior of a greater number of species are known. The Jurassic genus *Pteroperna*, for instance, has hinge teeth analogous to those of *Pterinia*, with apparently a cavity or depression for a cartilage, similar to that of *Avicula*. Such exceptional cases, however, cannot be urged as a reason for not admitting the convenience of sections or intermediate groups between families and genera, for it is highly probable that if we knew all the characters of all the species that ever existed, from the beginning of animal life to the present epoch inclusive, we would find all our groups blending imperceptibly together, or at least very far from being so sharply defined as they appear in works on natural history.

The *Pterinia* group, or subfamily, probably includes most of the Palæozoic species usually referred to *Avicula*, especially those from the Silurian and Devonian rocks. Indeed, we very much doubt the existence, during the deposition of the Palæozoic rocks, of true *Aviculas*, as that genus is known to Conchologists, and typified by the existing *A. hirundo*. At any rate, we have never seen a specimen, nor can we remember a figure, of any species showing the hinge of a true *Avicula*, from any of our American Palæozoic formations. All the Silurian and Devonian species with which we are acquainted, the hinge of which has been seen, appear to want the cartilage cavity of the modern *Aviculas*, and have the striated hinge facet, or the oblique hinge teeth (one or the other or both) of *Pterinia*, more or less distinctly marked. In addition to this, most of the Silurian and Devonian, as well as many of the Carboniferous species, the hinge of which is unknown, present more the external appearances of the European species figured by Goldfuss and others, in which the internal characters of *Pterinia* are known to exist.

Prof. McCoy some time since referred three of our American Palæozoic species—*A. demissa*, *A. pleuroptera* and *A. subfalcata*—to *Pterinia*; and the figures of *A.*

¹ See American Journal Sci. and Arts (2d ser.), XXXVII, March, 1864, 217.

² Ib. 216.

securiformis, Hall, show traces of the broad striated area of that genus. *A. flabella*, Conrad, from the Hamilton group, has also been found to be a true *Pterinia*.¹ From all that is therefore known in regard to the affinities of these extinct shells, we may safely infer that probably all of our Silurian and Devonian species, usually referred to *Avicula*, especially those of the Hamilton and Chemung groups, will be found to possess the characters of *Pterinia*, or of undescribed genera.

It is a fact worthy of note, that while the existing genera of the family *Pteriidae* or *Aviculidae*, form a group at once so natural and distinctly defined that Conchologists meet with little difficulty in deciding what particular forms it should include, the boundaries of the family were not always so sharply marked. For, when we undertake to classify the numerous extinct genera that were introduced, lived out their term, and passed out of existence at various periods during the immense interval of time between the first introduction of this type of life and the present epoch, the case is very different; since we find amongst the vast numbers of fossil species, types presenting various intermediate gradations between the modern representatives of this and some of the allied families. For instance, no Conchologist could be for a moment in doubt whether any particular species or genus of our existing mollusks belongs more properly to the *Aviculidae*, or to the *Pectinidae*. Yet in tracing these two families, by their fossil shells, back into the distant past, we meet with various types presenting such an assemblage of characters as to often render their proper distribution more difficult; especially since we have only the light of analogy to guide us in our conclusions respecting the structure of the softer parts of these extinct forms. Some of these peculiar species were formerly referred by many Palæontologists to the genus *Pecten*, and by others to *Avicula*; and even now, since the genus *Aviculopecten* has been established for their reception, authors are by no means agreed whether this genus should be classed with the *Pectinidae* or the *Aviculidae*.

Again, no one having even a small amount of conchological knowledge, need be at a loss in deciding to which of the two families, *Arcidae* or *Aviculidae*, any of our existing species of bivalves belongs. Yet in passing from group to group of the *Arcidae*, from the recent typical examples through some of the other modern forms, and thence through various extinct types, it will be observed that the hinge plates, or denticles, become more and more oblique, until in some of the Palæozoic genera, such as *Cyrtodonta*, *Vanuxemia*, *Dolabra*, &c., only a few obscure divisions are to be seen at the remote extremities of the hinge, ranging nearly or quite parallel to the cardinal margin, as in *Bakevellia*, *Pterinia*, and other genera apparently belonging to the *Aviculidae*. In addition to this, in many of the extinct groups of *Aviculidae*, such, for instance, as *Gryphorhynchus*, *Myalina*, *Bakevellia*, &c., there is as well a developed cardinal area, as we generally see in the *Arcidae*; while this area in

¹ See remarks on the family *Aviculidae*, by F. B. Meek, Am. Jour. Sci. and Arts (2d ser.) Vol. XXXVII, March, 1864, 46.

several of these ancient types is provided with cartilage furrows, as in the *Arcidæ*. Again in *Pterinia*, and some species of *Bakevellia*, we see the anterior muscular impression comparatively so well developed, that one can scarcely believe it was not made by a true adductor; while the eccentric position of the posterior muscular impression would seem also to favor the same conclusion; and yet in all their other known characters these forms agree with the *Aviculidæ*.

In another direction, some of these ancient groups of *Aviculidæ* seem to show a disposition to shade off towards the *Mytilidæ* or *Dreissenidæ*. Amongst the Carboniferous and Permian species of *Myalina*, for instance, we see shells presenting apparently exactly the form and general external appearances of the existing genera *Mytilus* and *Dreissena*, to which even yet some Palæontologists will persist in referring them. On a closer inspection, however, these Carboniferous and Permian species, when we can find them with the two valves united, are seen to be always a little inequivalve, while their hinge also differs from that of the *Mytilidæ* and *Dreissenidæ*, in having a flat cardinal area, with longitudinal cartilage furrows. In addition to these differences, we have ascertained that the shell structure of at least two species of *Myalina* (*M. perattenuata*, M. & H., and *M. angulata*, Meek & Worthen) is minutely prismatic, as in true *Avicula*.¹ It is true the same structure has also been observed by Dr. Carpenter in the inner layer of *Dreissena*; but the unquestionable inequivalve character of *Myalina*, in connection with its peculiar cardinal area, and the fact that these shells are always found associated with marine types, are sufficient evidences that they have no very close affinities to *Dreissena*.

SUBFAMILY PTERINIINÆ.

Genus MYALINA, KONINCK.

Synon.—*Mytilus* (sp.), SOWERBY, and others (not LAMARCK, 1801).

Myalina, KONINCK, AN. FOSS. 1842, 125 (not CONRAD, 1845).

Aucella, GEINITZ, DYAS, 1861 (not KEYSERLING, 1846, nor MCCOY, 1855).

Etym.—? *Mya*.

Examp.—*Myalina lamellosa*, KONINCK.

Shell mytiliform, or subrhomboidal, extremely inequilateral, moderately inequivalve, more or less oblique; valves apparently a little gaping and slightly sinuous in front for the passage of the byssus. Beaks pointed and nearly or quite terminal; sometimes provided with an internal shelf or septum apparently for the attachment of the anterior muscle. Surface smooth or with concentric markings of growth, which, in some species, form imbricating laminae. Hinge nearly or quite edentulous; ligament area usually broad, and marked by distinct cartilage? furrows parallel to the hinge line. Muscular and pallial impressions apparently as in *Pteria*.

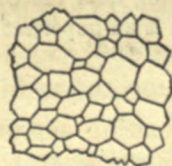
Animal unknown.

¹ See Am. Jour. Sci. XXXVII, March, 1864, 214.

Prof. Koninck described this genus as being equivalve—an error into which he was doubtless led by the distortion of his specimens. Prof. McCoy subsequently described it as inequivalve, which is undoubtedly correct, as we know from the study of our American species. As remarked by Prof. Koninck, the species often closely resemble *Mytilus* and *Perna* (Brug. not Adanson) in form; but the inequality of the valves, and the broad striated cardinal area, will distinguish them from the first—and the absence of deep vertical cartilage furrows in the hinge area, from the latter. They seem to be even more closely allied to the fresh-water genus *Dreissena*, with which some of the species agree exactly in form, excepting the slight inequality of the valves. They also sometimes possess an internal shelf or septum in each beak, as we see in that genus. We have likewise discovered that the shell structure is prismatic, as seen under a high magnifier, by transmitted light, as in the *Dreissenidæ* and *Aviculidæ*.

Were it not for the broad striated area, and the inequality of the valves, we would certainly be inclined, from all the facts, to place this genus in the *Dreissenidæ*, instead of the *Aviculidæ*. The prismatic structure of which we speak, settles the question in regard to these shells being distinct from the family *Mytilidæ*; but as this structure occurs both in the *Dreissenidæ* and the *Aviculidæ*, it is not alone so conclusive in regard to the relations of these shells to these two families. Further examinations, however, may yet enable us to decide this point, since in the *Aviculidæ* the inner layer of the shell is not prismatic, but pearly, and the outer layer only is prismatic; while in the *Dreissenidæ* there is no pearly interior—the inner layer being prismatic, as are the succeeding portions, excepting the very exterior. As the nacreous portion of shells is most frequently destroyed during the process of fossilization, it is difficult to determine very satisfactorily whether it was really the inner or outer layer in which we saw the prismatic structure—the shell being very thin, and apparently more or less exfoliated in the specimens examined. Our impression, however, is that it was the outer layer, or at any rate not the innermost; which would favor the conclusion that these shells belong to the *Aviculidæ*, as their inequivalve character, and broad cardinal area indicate.

The annexed cut shows the prismatic structure as seen in a fragment of *Myalina angulata*, placed in Canada Balsam, under a magnifying power of about 350 diameters.



Shell structure of *Myalina angulata*, magnified 350 diameters.

The genus *Myalina* seems to have been introduced during the latter part of the Devonian epoch, or soon after the beginning of the Carboniferous, and probably attained its maximum development during the deposition of the Coal Mea-

tures.¹ It also occurs in the Permian rocks, and may possibly range up into the Trias.

Myalina perattenuata.

(PLATE I, Fig. 12, *a*, *b*.)

Myalina perattenuata, MEEK & HAYDEN, Trans. Albany Institute, IV, March 2, 1858.

Shell very thin and fragile, obliquely elongate, narrow and slightly arcuate; valves convex anteriorly, and compressed behind. Beaks pointed, terminal and attenuate; hinge line equalling rather more than half the entire length of the shell, and ranging at an angle of about 50° above the oblique anterior margin. Posterior border sloping from the end of the hinge, nearly parallel to the anterior side above, and rounding to the narrow antero-basal extremity below; anterior margin of the valves a little areolate, and rather abruptly deflected inwards from the umbonal ridge above the middle, and in outline nearly straight below. Umbonal slopes prominent from the beaks down the anterior side. Surface with obscure subimbricating marks of growth.

Length from the beaks to the postero-basal extremity, 1.50 inch; breadth, 0.65 inch; convexity, about 0.44 inch.

This species will be recognized by its slender attenuate form, and very thin shell. Like other species of the genus, it seems to have varied more or less in form, a portion of the specimens being straighter on the anterior margin than others. We know of no species with which it is liable to be confounded. *Myalina* (*Modiola*) *minor*, Lea (Jour. Acad. Nat. Sci. Phila., Vol. II, 2d ser., p. 205) seems to be an analogous species, but is more finely and regularly striated.

Locality and position.—Opposite the northern boundary of Missouri, on the Missouri River. From seams of yellowish magnesian limestone, in the Coal Measures. (Type 1022*a*.)

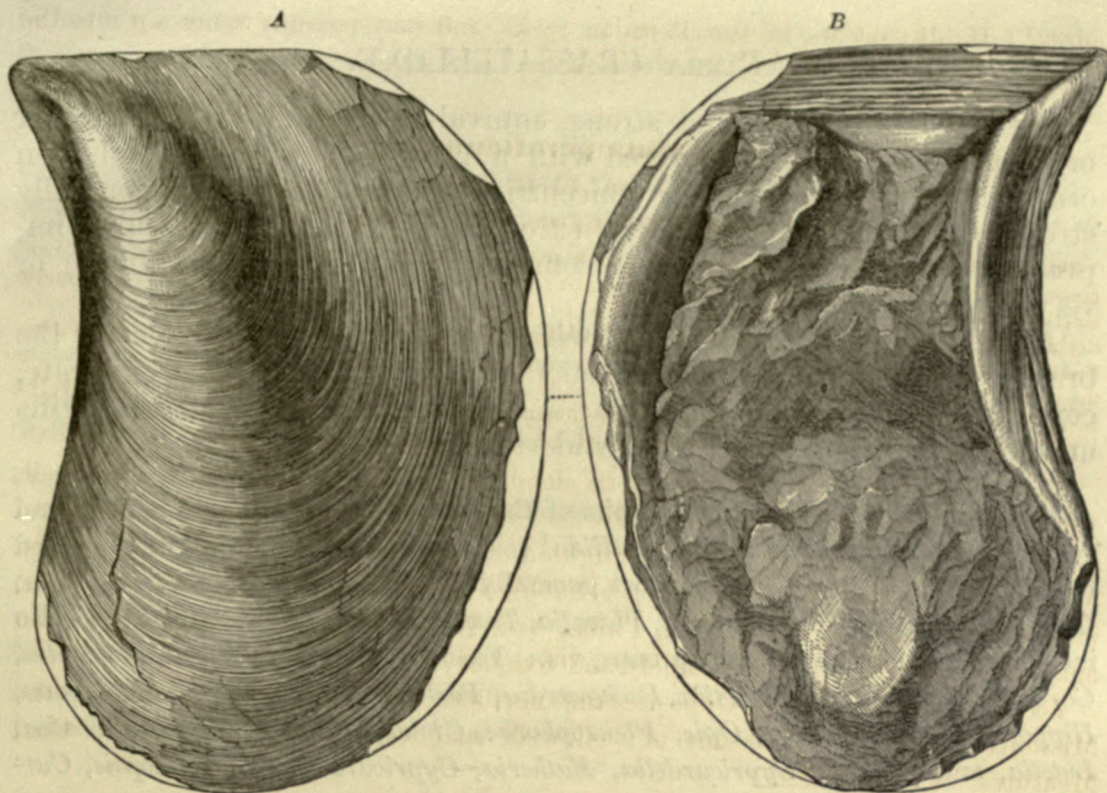
Myalina subquadrata.

Myalina subquadrata, SHUMARD, Geol. Report Missouri, part Palaeontology, p. 207, pl. C, fig. 17, *a*, *b*.

Shell attaining a large size, compressed and somewhat alate in the postero-dorsal region, and convex anteriorly—considerably higher than long; posterior margin forming a broad gentle curve, being nearly straight and ranging almost vertically near the middle, and curving forward so as to intersect the hinge at an obtuse, undefined angle above, while below it arches regularly forward into the rather narrowly rounded base; anterior margin thickened within above, broadly arcuate or concave in outline, its curvature being nearly parallel to that of the posterior margin. Beaks terminal, directed forward; umbonal ridge most prominent and oblique above, and in adult shells curving downwards so as to range nearly vertically near the middle. Hinge line straight, and ranging nearly at right angles to the longer, or vertical axis of the valves; cartilage furrows distinct, straight, and in mature shells numbering about ten or twelve; area broad. (Muscular impressions unknown.)

Height about 4 inches; antero-posterior diameter at the middle, 2.40 inches; convexity of a left valve, 0.83 inch.

¹ Prof. Hall refers an Upper Silurian shell, from the Clinton Group (Pal. N. Y. Vol. II, p. 100, pl. xxx), to this genus; but as his specimen is an imperfect cast, its true relations remain doubtful.

*Myalina subquadrata.*

A. Outside of a left valve somewhat weathered. B. Hinge view of same.

In size and general appearance this shell resembles *Myalina subquadrata*, of Shumard, to which we have concluded to refer it provisionally, on the authority of Dr. S., to whom we sent the above cuts for comparison. It will be observed, however, on comparing our figures with those of the typical specimen of *M. subquadrata*, published in the Missouri Report, that our shell differs in having its posterior margin curving forward above, so as to intersect the hinge (as may be seen by the direction of the lines of growth) at an obtuse undefined angle, instead of being nearly straight and intersecting the hinge at right angles. This peculiarity gives a different expression to the posterior outline of the shell, that had led us to think it probably distinct. Should it be found, when we can have an opportunity to compare a series of specimens, that this difference is constant in adult examples, the propriety of separating these two forms can scarcely admit of a doubt, in which case the form under consideration may be designated as *Myalina ampla*.

Locality and position.—Leavenworth City, Kansas, from a thin layer of impure limestone near the level of the Missouri River. Coal Measures. (Type No. 998.)

5 April, 1864.

FAMILY CRASSATELLIDÆ.

Shell generally thick and strong, equivalve, oblong, oval, subcircular or subtrigonal. Surface covered with a brownish epidermis, and often ornamented with radiating or concentric costæ. Hinge with generally strong cardinal teeth; ligament external or internal. Muscular impressions usually deep and well defined; pallial impression simple or very slightly sinuous.

Animal (in the typical genus) with mantle lobes only united by the branchial septum; margins of inhalent orifices cirrhatated; foot moderate, compressed, more or less triangular, and grooved. Palpi triangular; gills unequal, outer semi-lunar, inner widest anteriorly.

Authors differ in regard to the limits of this family, some including in it several genera which others refer to the *Veniliidæ*¹ (= *Cyprinidæ*), or to some of the allied families. The existing genera most generally placed here, are *Astarte*, *Gouldia*, *Crassatella*, *Cardita*, *Carditamera*, *Thecalia*, *Trapezium*, *Coralliophaga*, &c. It also includes the following extinct groups, viz.: *Venericardia*, *Pachydomus*, *Astartella*, *Cardinia*, *Carbonocola*, *Astartila*, *Pachycardia*, *Pachyrisma*, *Megalodon*, *Mecynodon*, *Hippopodium*, *Myoconcha*, *Opis*, *Pleurophorus*, *Cleidophorus*, *Erycinella*, *Woodia*, *Lutetia*, and probably *Cypricardella*, *Matheria*, *Cypricardina*, *Anodontopsis*, *Curtonotus*,² &c.

Genus PLEUROPHORUS, KING.

Synon.—*Nuculites* (sp.), CONRAD, Ann. Report Geol. N. Y. 1841, 48.

Pleurophorus, KING, Ann. Mag. Nat. Hist. XIV, 1844, 313.—DE VERNEUIL, Bull. Soc. Geol. Fr. 1844 (2d ser.),

1.—KING, Monogr. Perm. Foss. Eng. 1850, 180.

Cleidophorus, HALL, Palæont. N. Y. I, 1847, 300.

Clidophorus, MCCOY, Palæozoic Fossils, 1852, 273.

Etyim.—πλευρά, a rib; φέρω, to bear.

Type.—*Arca costata*, BROWN.

Shell generally small, longitudinally oblong or subovate, inequilateral; cardinal teeth two in each valve, interlocking alternately, and more or less divergent; posterior lateral teeth one to each valve, the receiving tooth in the left valve. Anterior adductor muscular scar deep, and bounded posteriorly by a ridge; pallial line simple.

This genus may be distinguished from *Cardita*, by its depressed, elongate form, as well as by its upper cardinal tooth in the right valve being elongated posteriorly, and by having true posterior lateral teeth. From *Cypricardia*, and *Carbonocola*, it differs in having the receiving tooth in the left, instead of the right valve. From *Carditamera*, with which it agrees in the arrangement of the lateral teeth, it differs

¹ The name *Cyprinidæ* having been long in use for a family of fishes, ought not to be retained for this group.

² It is desirable that the author of this genus should select another name for it, *Curtonotus* having been used by HANN for a genus of *Crustacea*, in 1835.

in having a short upper cardinal tooth; and in being destitute of anterior teeth. It also resembles *Coralliophaga*, from which, however, it is clearly distinguished by its simple pallial line.

Prof. McCoy, who has had an opportunity to compare typical specimens of *Cleidophorus*, with examples of *Pleurophorus* showing the hinge, says they agree exactly in their dentition, and it is on his authority that we here regard them as synonymous. Our description of the hinge is taken from Prof. King's carefully written description of *Pleurophorus*.

Prof. Hall's name, however, may, we think, be properly retained in a subgeneric sense, for a section of this group probably confined to the Silurian rocks. This subgenus may be distinguished from the typical costated species found in the more modern formations, by the following characters:—

Cleidophorus, HALL.

Shell without radiating postero-dorsal costæ. Internal ridge bounding the scar of the anterior adductor, descending with a slight forward slope.

Type.—*Nuculites planulata*, CONRAD.

The genus *Pleurophorus*, as here defined, was introduced during the Lower Silurian epoch, where it was represented by the smooth species. It also ranges through the Carboniferous and Permian rocks, as stated above, into the Trias, the more recent species being the typical forms.

Pleurophorus occidentalis.

(PLATE I, Fig. 11, a, b.)

Pleurophorus? occidentalis, MEEK & HAYDEN, Trans. Albany Institute, IV, March 2, 185.

Shell small, narrow, somewhat elongate; valves moderately convex along the umbonal slopes. Basal and dorsal margins nearly straight and subparallel, or converging slightly toward the front; posterior side rounded, and rather compressed; anterior side rounding up gradually from the base. Beaks small, depressed, and located at the anterior extremity; hinge line long and straight. Surface with a few concentric marks, and traces of finer lines of growth, which are crossed by some four or five small faintly defined radiating costæ, extending from the beaks obliquely backwards and downwards to the posterior, and postero-basal margins.

Length, 0.37 inch; height, 0.16 inch; breadth, or convexity of the two valves, about 0.14 inch.

Not having seen the hinge or interior of this little shell, we are not sure it really belongs to the typical group *Pleurophorus*. It agrees, however, so nearly in its external characters, with *P. costatus*, as figured by Prof. King in his work on the Permian fossils of England, that we are strongly inclined to think it will be found to possess a similar hinge. Specifically, it differs from *P. costatus*, in being much smaller, more depressed, and more contracted in the antero-ventral region.

Locality and position.—Nebraska, nearly opposite the northern boundary of Missouri. Coal Measures. (No. 1017.)

FAMILY ANATINIDÆ.

Shell thin, often inequivalve, inequilateral, more or less gaping posteriorly, pearly within. Surface, in well preserved specimens, generally granulose, concentrically or radiately striate or costate. Hinge teeth usually rudimentary or obsolete; ligament external, thin; cartilage occupying an internal pit or cavity under the beak of each valve, and usually provided with a free ossicle. Beaks sometimes fissured. Muscular impressions faint; pallial line generally sinuous.

Animal with long, more or less separated siphons, which are fringed at the extremities; mantle with united margins, provided with a valve-like opening under the siphons; gills single on each side, pinnate—outer laminae prolonged dorsally beyond the line of attachment.

A number of fossil genera appear to belong to this family, though their affinities have not been very clearly determined. It is possible some of those mentioned below may belong to one or more distinct families; but until their relations can be made out more satisfactorily, from the study and examination of the hinge and interior of a larger number of species, we prefer to place them here.

The existing genera, properly included in this group, are *Anatina*, *Periploma*, *Thracia*, *Lyonsia*, *Mytilimeria*, *Poromya*, *Myodora*, *Pandorella*, *Cælodon*, *Pandora*, *Clidiophora*, *Theora*, *Næra*? *Tyleria*, and *Pholadomya*.

The extinct groups, apparently belonging here, are *Margaritaria*, *Cercomya*, *Anatimya*, *Allorisma*, *Myacites*, *Homomya*, *Anthracomya*? *Chænomya*, *Platymya*, *Arcomya*, *Mactromya*, *Goniomya*, *Gresslya*, *Cardiomorpha*, *Ceromya*, *Sedgwickia*, *Sanguinolites*, and probably *Cleobis* and some of the species included in the genus *Orthonota*.

Genus ALLORISMA, KING.

Synon.—*Sanguinolaria (gibbosa)*, SOWERBY, Min. Conch. VI, 1814, 92.

Myacites (sp.), SCHLOT. ? Petrefact. 1820, 176.

Hiatella (sulcata), FLEMING, Brit. An. 313.

Pholadomya (elongata), MORTON, Am. Jour. Sci. XXIX, 1836.

Sanguinolites (part), MCCOY, Carb. Foss. Ireland, 1844, 47.

Allorisma, KING, Ann. Mag. Nat. Hist. XIV, 1844, 315; Mon. Permian Foss. England, 1850, 196.

Etym.—ἀλλοῖος, variable; ἔμισμα, support.

Examp.—*Hiatella sulcata*, FLEMING.¹

Shell equivalve, inequilateral, elongate, thin; anterior side short; posterior side long and somewhat gaping at the extremity; beaks depressed, anterior. Surface minutely granulose, and ornamented with more or less distinct concentric ridges

¹ As first defined by Prof. King, this genus was made to also include species belonging to the genus *Edmondia*. We observe that he remarks in a foot-note to page 196 of his Monograph of the Permian Fossils of England, published in 1850, that he avails himself of that opportunity to name *Hiatella sulcata* as the type of this genus, instead of *Allorisma regularis* of Murchison, Verneile & Keyserling's work on the Fossils of Russia; because he thinks the latter more probably an *Edmondia*.

or undulations. Hinge edentulous; ligament apparently wholly external. Dorsal margin inflected so as to form a lanceolate depression or false area along the cardinal border behind the beaks. Scar of anterior adductor muscle occupying a comparatively low position. Pallial line faintly marked; its sinus sometimes deep, rounded or angular.

Animal unknown.

We are rather at a loss to find well marked and constant external characters by which the shells of this genus can be always readily distinguished from some of the Triassic and Jurassic forms usually referred to *Myacites*, and included by Prof. Agassiz in the groups for which he proposed the names *Pleuromya* and *Myopsis*. Indeed some of our Devonian and Carboniferous species, if found in Triassic or Jurassic rocks, would be at once referred to *Myacites*, *Pleuromya*, or *Myopsis*, by most Geologists. As observed by Prof. Agassiz, the shells included by him under the latter two names are very closely allied, and it was mainly in consequence of the presence of cardinal teeth, and a granulated surface in several of the species of *Myopsis* (characters not observed in those referred to the group he called *Pleuromya*), that they were separated. Some subsequent European investigators, however, say they find these characters common to species included in both groups. If these observers are not mistaken, these two groups should probably be united under the older name *Myacites*, from which the genus under consideration would be mainly distinguished by its edentulous hinge. The *Allorismas* are, however, also generally longer shells, with more depressed beaks, and they were probably never so widely gaping behind as some species of *Myacites*.

From the genus *Pholadomya*, to which this group is related, it can always be distinguished by the total absence of the radiating costæ so characteristic of that genus. They likewise differ in the granulated character of the surface, though it is rather rarely the case that we find specimens in a condition to show this latter peculiarity.

The genus *Allorisma* appears to have been first introduced during the Devonian epoch, and attained its maximum development before the close of the Carboniferous. It also occurs in the Permian rocks, and, as already stated, some very similar forms have been described under the name of *Myacites* from the Triassic and Jurassic rocks.

Allorisma subcuneata.

(PLATE I, Fig. 10, a, b.)

Allorisma subcuneata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 263.

Comp. *Sanguinolites clava*, MCCOY, Brit. Pal. Foss. 1852, Fasc. III, 504, pl. 3 F, fig. 12.

Shell large, clayato-cuneate, gibbous in the anterior and umbonal regions; narrowed and compressed posteriorly. Beaks depressed, incurved, and located about one-eighth the entire length of the shell from the anterior extremity. Posterior end narrowly rounded, and apparently moderately gaping; anterior end obliquely subtruncate above, and rather narrowly rounded and somewhat produced below; basal margin nearly straight along the middle, contracting

This, however, was unnecessary, since he had distinctly stated in first publishing the genus in the *Annals and Mag. Nat. Hist.* Vol. XIV, 1844, p. 315, that it "is represented by *Sanguinolaria sulcata* of Phillips."

very gradually behind, and rounding up more abruptly in front; dorsal margin nearly parallel to the base, or declining a little posteriorly. Surface of internal casts marked by rather small, moderately distinct concentric undulations, which are quite regular over the umbones, but become more irregular and obscure towards the margins of the valves.

The hinge is long, and nearly straight. In casts there is a rather narrow depression extending along its entire length, bounded on either side by an obtuse ridge, ranging parallel to the hinge line. Immediately outside of each of these ridges there is a shallow rounded sulcus, which is widest near the posterior muscular scar, and becomes narrower, and less distinct towards the beaks. The anterior muscular impression is well defined, transversely lunate in form, and connected with the pedal scar above in such a manner that the two together present much the appearance of a capital letter G, lying on its back. The posterior muscular scar is large, broad rhombic-subovate in form, and placed near the hinge, about one-third the entire length of the shell from the posterior extremity. The pallial line is faintly marked, and apparently provided with a deep acutely angular sinus.

Length, 5.10 inches; height, 2.25 inches; greatest thickness or convexity near the anterior end, 1.70 inch.

This species is very closely allied to *Sanguinolites clara*, of McCoy (cited at the head of this description), and may possibly prove to be identical, when a direct comparison of specimens can be made. Those we have yet seen, however, of the Kansas fossil, differ from Prof. McCoy's figures in being straighter on the dorsal margin, and more produced, as well as more narrowly rounded in the antero-ventral region. Their concentric undulations are also more obscure, and the lunule-like depression in front of the beaks less distinctly defined, in our shell.

Locality and position.—Leavenworth City, Kansas, from a bed holding a position a few feet above low-water mark of the Missouri. Coal Measures. (Type 1020.)

Genus SEDGWICKIA, McCoy.

Synon.—*Sedgwickia*, McCoy, Synopsis Carb. Foss. Ireland, 1844, 61.

Leptodomus, McCoy, British Pal. Foss. 1852, 277 (not 1844, Carb. Foss. Ireland, p. 66).

Sanguinolites (part), McCoy, Brit. Pal. Foss. 1852, 276 (not Carb. Foss. Ireland, 1844, p. 47).

Etym.—Dedicated to Rev. Adam Sedgwick, M. A., F. R. S.

Type.—*Sedgwickia attenuata*, McCoy.

Shell depressed oblong, or suboval, nearly or quite equivalve, inequilateral, very thin; anterior side not quite closed, often a little gibbous; posterior side longer, more compressed, and more widely gaping. Beaks prominent, rather tumid, incurved; posterior umbonal slopes prominently rounded, or sometimes forming an oblique ridge, generally separated from the compressed postero-dorsal region by a shallow, linear sulcus, which is also sometimes marked on internal casts. Flanks compressed, or somewhat concave in the antero-ventral region, or a little behind it. Lunular impression distinct. Surface finely granulose, and ornamented with more or less regular concentric ridges and striæ, the ridges being usually obsolete on the posterior and compressed postero-dorsal portions of the valves. Hinge edentulous; cardinal margin inflected so as to form a narrow false area behind the beaks. (Muscular and pallial impressions very obscure and not well known; animal unknown.)

This group, as here defined, agrees in all essential characters with *Leptodomus*, as characterized in 1852 by Prof. McCoy, in his beautiful work on the British Palæozoic Fossils. We think, however, that this name cannot be retained, in

accordance with the established rules of nomenclature, for these shells, because the type of the genus *Leptodomus*, as originally founded by Prof. McCoy (*L. fragilis*, Carb. Foss. Ireland, 1844, 66), apparently belongs to an entirely different group. On turning to Prof. McCoy's figure of this species (Ib. pl. x, fig. 11), it will be seen to be a short, high, ventricose shell, with gibbous distinctly incurved beaks, and a nearly smooth, or merely striated surface, and rather well marked muscular impressions. Indeed we are led by Prof. McCoy's figure and description to think this shell not generically distinct from some of the forms included by Prof. Koninck in his genus *Cardiomorpha*, though it may be a *Schizodus*, King.

On the other hand, we think the shells under consideration, are not generically distinct from *Sedgwickia*, McCoy, as originally proposed by him in his Synop. Carb. Foss. 1844, p. 61, and typified by his *S. attenuata* (Ib. p. 62). It may be, however, that Prof. McCoy dropped the name *Sedgwickia*, because it had been used several times in Botany. Still we cannot regard this as a sufficient reason for setting the name aside, for there are numerous instances where the same name is retained for genera in Botany and Zoology. In addition to this, the particular genus for which Botanists now retain the name *Sedgwickia*, was published by Griffith, since the publication of Prof. McCoy's genus. Even if we admit, however, the propriety of abandoning the name *Sedgwickia*, these shells cannot be properly referred to *Leptodomus*, we should think, until it can be demonstrated, or at least rendered probable, that they are congeneric with the type of that genus—*L. fragilis*, McCoy.

It is worthy of remark, also, that these shells resemble the typical *Allorismas* in so many points that we have some doubts whether they should be separated more than as a sub-genus. They are also rather closely allied to *Myacites*, as affirmed by Munster. From the typical species of the former genus, they differ in being shorter and usually more gibbous shells, with more prominent beaks and umbonal slopes. They also differ in having the postero-dorsal region more compressed, and the cardinal margin more concave in outline behind the beaks. These peculiarities give these shells a *Lyonsia*-like aspect apparently never seen in the true *Allorismas*. In their less elongated form, and more prominent beaks, they approach nearer some species of *Myacites*, but differ in the other characters mentioned.

From the genus *Sanguinolites*, as originally defined, and typified by *Sanguinolaria? angustata* of Phillips (McCoy, Carb. Foss. Ireland, 1844, 47 and 48), our shells differ in being proportionally much shorter, more gibbous, less depressed, and not near so straight and parallel on their dorsal and ventral margins. Until something, however, can be determined in regard to the hinge or muscular and pallial impressions of *Sanguinolites angustatus*, the type of that genus, we can form no satisfactory conclusions in regard to its limits. It is true, Prof. McCoy, in re-describing this genus, in his Brit. Pal. Foss. 1852, describes the muscular and pallial impressions; but it is manifest these characters were taken from his *S. iridinoïdes*, and other forms, that may or may not be congeneric with the species *angustatus*. Should the *S. iridinoïdes*, however, really be congeneric with that species, which is not improbable, it would rather confirm the conclusion that the short gibbous shells under consideration are generically distinct, than the contrary.

The following species seem to be congeneric with the original type of *Sedgwickia*, viz.: *S. costellata* (= *Sanguinolites (Leptodomus) costellatus*, McCoy, Brit. Pal. Foss. pl. 3, F, fig. 5); *S. variabilis* (= *Sanguinolites variabilis*, McCoy, ib. fig. 6); *S. truncata* (= *Leptodomus truncatus*, McCoy, ib. pl. 1, K, fig. 21 and 24), and *S. granosa* and *S. topekaensis* (= *Leptodomus granosus* and *L. topekaensis*, Shumard, Trans. St. Louis Acad. I, p. 207-8).

If we are right in referring *Leptodomus truncatus*, McCoy, to this genus, it would carry back the origin of the group at least to the Upper Silurian epoch. Some similar forms also occur in the Devonian rocks, and the genus probably attained its greatest development during the deposition of the Carboniferous Series. Several species presenting very similar external appearances have also been described under the names *Myacites*, *Cypricardia*, &c., from the Triassic and Jurassic deposits; but we have little or no knowledge of the true affinities of many of these shells, and consequently cannot pretend to define, with precision, the geological range of the genus *Sedgwickia*.

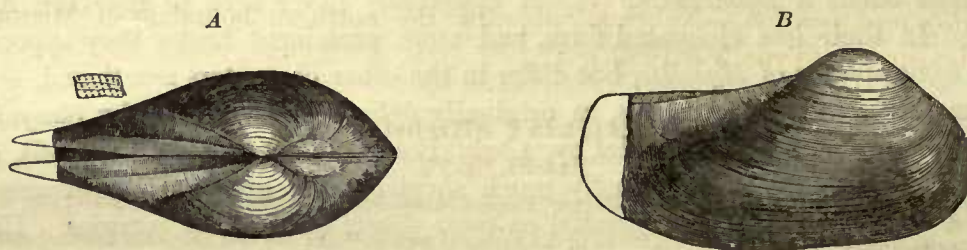
***Sedgwickia topekaensis*?**

Leptodomus Topekænsis, SHUMARD, Trans. St. Louis Acad. Sci. I, 1858, 208.

Shell depressed subovate, about twice as long as high, extremely thin and fragile, gibbous in the region of the beaks, and along the oblique umbonal slopes. Sides flattened above, and becoming a little concave towards the base in front of the middle. Dorsal border nearly horizontal, and slightly concave in outline behind the beaks, where its inflected edge is margined by a rather distinct ridge; ventral border presenting a broad semi-ovate outline, excepting a very slight sinuosity just in advance of the middle—rounding up abruptly in front and more gradually behind; anterior side prominent, gibbous, and narrowly rounded below, obliquely truncated above; posterior side compressed, narrowed, and apparently subtruncate and somewhat gaping at the extremity. Lunular impression in front of the beaks (in casts) moderately distinct, defined by a faintly impressed line. Beaks prominent, gibbous, a little flattened, incurved, and placed between the middle and the anterior extremity, but nearer the former.

Entire surface, in well preserved specimens, closely covered with minute granules arranged in radiating rows; and ornamented with small concentric ridges, which are most regular and distinct on the umbones, and end abruptly along an impressed line extending from the posterior side of each beak obliquely towards the postero-basal margin, thus leaving the compressed postero-dorsal region comparatively smooth. (Muscular and pallial impressions unknown.)

Length about 2 inches; height, 1 inch; convexity, 0.75 inch.



Sedgwickia topekaensis?

A. Dorsal view, partly restored, one valve being distorted in the specimen.

B. Side view of same.

This shell is closely related to *S. granosa* (*Leptodomus granosus*, Shumard), but seems to agree more nearly, when all its characters are taken into consideration, with the form described by him under the name *Leptodomus topekaensis*; particularly in the possession of a shallow linear sulcus extending from the back part of each beak, towards the postero-basal margin. It is true, Dr. S. does not mention the presence of fine granules on the surface of the species *Topekaensis*, while this is one

of the characters of his *granosa*. The apparent absence of granules, however, on the former may be due to the condition of the specimen, as this is a character easily obliterated by wearing. Of the known foreign species, its nearest representative is perhaps *Sanguinolites variabilis*, McCoy (Brit. Pal. Foss. pl. 3, F, fig. 6-7), from which it differs in being much narrower posteriorly, and in having a proportionally longer hinge line, particularly as compared with adult specimens of McCoy's species. Its antero-ventral region is also more prominent than that of *S. variabilis*.

Locality and position.—Leavenworth City, Kansas; it occurs both in the hills back of the town, 200 to 250 feet above the Missouri, and in beds of impure limestone near the landing, little above the level of the river. Coal Measures. (Type No. 1011.)

Sedgwickia? concava.

(PLATE I, Fig. 8, a, b.)

Lyonsia concava, MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858.

Shell small, elongate-oval; valves moderately convex in the umbonal and anterior regions. Extremities rounded; posterior end compressed, apparently a little gaping; base nearly straight along the middle, and rounding up at the extremities; dorsal outline concave behind the beaks—declining in front. Beaks rather depressed, incurved, and located about half-way between the middle and the anterior extremity. Surface of casts with a few more or less distinct marks of growth. (Hinge, muscular and pallial impressions unknown.)

Length, 0.65 inch; height, from base to top of beaks, 0.30 inch; convexity, 0.23 inch.

In first publishing a description of this species, we placed it provisionally in the genus *Lyonsia*, stating, at the same time, that our specimens were merely casts, and that we were consequently left in doubt in regard to its generic relations. Subsequent examinations of other specimens have satisfied us, however, that it can scarcely be a *Lyonsia*—there being no impressions in well preserved internal casts, of the projecting cartilage plates so characteristic of that genus. This being the case, we now place it with doubt, in the genus *Sedgwickia*, to which it appears to be more nearly related; but in so doing, we should remark that until specimens showing the hinge, and other internal characters can be examined, its true affinities cannot be determined with any degree of confidence.

Locality and position.—Nebraska, opposite the northern boundary of Missouri. Coal Measures. (Type No. 1023.)

Sedgwickia? altirostrata.

(PLATE I, Fig. 9.)

Allorisma? altirostrata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 263.

Shell longitudinally oblong-oval, very gibbous in the umbonal region; beaks elevated above the cardinal margin, incurved, and located almost directly over the anterior edge. Posterior side rather broadly and regularly rounded, apparently gaping; anterior side subtruncate, a little gaping, and rounding into the base below; ventral border nearly straight, or somewhat concave in outline near the middle, and rounding up at the extremities. Cardinal margin straight, rather short. Surface of cast ornamented by concentric undulations, which are small, regular, and well defined on the umbonal slopes, but become less distinct, and more irregular near the margins of the valves. Just in front of the most prominent part of the oblique umbonal ridge of each valve there is a moderately distinct, narrow, undefined sulcus, extending backwards and downwards to the middle of the base.

Length, about 3.06 inches; height, from the base to the dorsal margin, 1.57 inch; do. to the highest part of the beaks, 1.74 inch; greatest convexity of the two valves, 1.62 inch.

It is only provisionally we place this species in the genus *Sedgwickia*, not having seen any specimens showing the hinge; while the form of the shell is different

from that of the typical species, the nearly terminal position and greater elevation of the beaks giving it much the physiognomy of many species of *Pholadomya*. Indeed, it only wants radiating costæ to present all the *external* characters of that genus. It is more nearly related to *Pholadomya Omaliana*, Koninck, than to any other shell with which we are acquainted, from any part of the Carboniferous system. Yet it differs in having more elevated, and rather more nearly terminal beaks, as well as in the possession of an oblique sulcus in front of the umbonal slope of each valve. The concentric undulations are likewise more distinct and regular on its flanks, and its antero-ventral region is less prominent.

It is probable that this shell will be found to present internal characters warranting its separation, either as a sub-genus, or as a distinct genus, from *Sedgwickia*. If so, we would propose for the group the name *Exochorhynchus* (ἐξοχος, prominent; ἑργχος, beak). It would include *E. (Pholadomya) Omaliana*, of Koninck.

Locality and position.—Juniata, on Big Blue River, Kansas. Coal Measures. In the paper cited at the head of this description, Grasshopper Creek was, by some oversight, erroneously given as the locality from which this species was obtained. (Type 1021.)

Genus CHÆNOMYA, MEEK.¹

Synon.—*Mya* (sp.), PHILLIPS, Geol. York. I, 1835, 157 (not LINN.).

Panopæa (sp.), D'ORBIGNY, Prodr. de Palæont. I, 1850, 273.—MEEK & HAYDEN, Trans. Albany Inst. IV, March, 1858, 11 (not MENARD).

Myacites (sp.), MORRIS & LYCETT, Moll. Great Oolite, 1853, 114 (not SCHLOT.; MUNSTER).

Allorisma? (sp.), SWALLOW, Trans. St. Louis Acad. I, 1858, 194.—MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 263 (not KING, 1844).

Etym.—*χαίω*, to open or gap; and *Mya*.

Type.—*Allorisma? leavenworthensis*, MEEK & HAYDEN.

Shell thin, equivalve, longitudinally oblong, subcylindrical. Anterior side rounded, closed; posterior side long, distinctly truncated, and very widely gaping, or even dilated at the extremity. Beaks depressed and located in advance of the middle. Surface minutely granulose, and usually provided with obscure concentric undulations, and more or less distinct lines of growth. Cardinal margins more or less inflected, as in *Allorisma*; ligament apparently entirely external; hinge edentulous. Posterior muscular impressions placed near the posterior extremity of the dorsal margin; scars of the anterior adductor and pedal muscles connected. Pallial line with a broad shallow sinus.

¹ Since this description was placed in the hands of the printer, we have been led to suspect, from some incidental allusions to the genus *Anthracomya*, in a lecture by Prof. Salter, published in the London Geologist, that the group here described may possibly be identical with that genus. As we have not yet seen the description of *Anthracomya*, however (the Memoir in which it was published not being in the Smithsonian Library, nor any of those at Cambridge, New Haven or Philadelphia), we are left in doubt, and have concluded we would probably be less liable to err by proposing a new genus, than by referring our shells to *Anthracomya*. Should they prove to belong to Mr. Salter's genus, however, we will cheerfully accept for them, the names *Anthracomya leavenworthensis*, *A. Cooperi*, and *A. minnehaha*.

This genus seems to be closely allied to some of the species included by Prof. Agassiz in his genus *Platymya*—particularly to his *P. tenuis*. It differs, however, from *P. dilatata*, the type of the genus *Platymya*, in being subcylindrical instead of compressed, and in having the posterior side distinctly truncated and very widely gaping. Again it differs in having the surface covered with minute granules—a character not observed in any of the species referred to the genus *Platymya*. Prof. Agassiz, to whom we showed our specimens, concurs with us in the opinion that they are not congeneric with the forms upon which he founded his genus.

From *Allorisma* of King, and *Pleuromya*, Agassiz, as well as the typical species of *Myacites*, the species included in this group may be at once distinguished, by their truncated and widely gaping posterior end, and less prominent antero-ventral region, as well as by the more elevated position of the scar of the anterior muscular impression. All the species yet known are also destitute of any traces of a shallow depression extending from the beaks to the antero-ventral margin, so commonly seen in *Myacites*, while they want the cardinal teeth generally present in that genus. Again, they seem to have differed in their habits from the species generally placed in *Allorisma*, which were probably, as suggested by Prof. King, surface-creeping mollusks. At any rate, we observed in numerous instances while in Kansas, where specimens of *Allorisma* were to be seen side by side in the same bed with the typical species of the group under consideration, that the latter were, in nearly every instance, found imbedded at right angles to the plane of the strata, with the open posterior extremity upwards, as if in their normal position as burrowing shells; while the *Allorismas* were generally found lying in a horizontal position.

From the genus *Panopæa*, which our Kansas shells closely resemble in form, they differ in their greater thinness, faintly marked pallial line, granular surface, and entirely edentulous hinge.

This genus, as here defined, commences in the Coal Measures, and ranges up at least into the Great Oolite, if not higher. It includes *Chanomya dilatata* (= *Mya dilatata*, of Phillips), and probably several other Jurassic species; also our *Panopæa Cooperi*, and *Chanomya Minnehaha* (= *Allorisma? Minnehaha*, of Swallow), from the Upper Coal Measures of Kansas.

***Chanomya leavenworthensis*.**

(PLATE II, Fig. 1, a, b, c.)

Allorisma? leavenworthensis, MEEK & HATDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 263.

Shell oblong subcylindrical; anterior side rounded, a little compressed and apparently entirely closed; posterior side long, truncated, and very widely gaping, the margins being even a little reflexed. Base nearly straight, or slightly convex in outline, rounding up gradually in front, and very abruptly behind; dorsal side concave in outline from the beaks to its elevated posterior extremity, and nearly parallel to the base. Beaks rather depressed, somewhat flattened, incurved, nearly or quite touching, and located about half way between the middle and the anterior end. Surface marked by fine lines of growth, and a few irregular, nearly obsolete concentric undulations, which curve up abruptly behind, parallel to the truncated posterior margin; crossing these, the radiating rows of minute granules may be seen by the aid of a good lens, on well preserved specimens.

Internal casts of this species show quite distinctly the scar of the anterior adductor muscle, which is oval, and located near the buccal margin, with its longer axis nearly at right angles to that of the shell. At its upper extremity the small oval pedal scar is also well defined in both valves. The posterior muscular impression is broad oval, and rather faintly marked; from near the middle of its under side the pallial line descends with a gentle forward curve, so as to form a broad, rounded, very shallow sinna.

Length, 2.85 inches; height, from the ventral margin to middle of the dorsal side, 1.36 inch; do., from the base

to a line drawn from the beaks across to the most elevated part of the posterior extremity, 1.50 inch; greatest convexity near the middle, 1.11 inch; breadth of posterior hiatus, 1.07 inch; height of do., 1.44 inch.

This species is so nearly like *Mya dilatata*, Phillips (as figured by Morris & Lyatt, Moll. Gt. Ool. vol. X, fig. 5), from the English Oolite, that if found imbedded with it in the same rock, they might, on a hasty examination, be mistaken for varieties of the same shell. On comparison, however, it will be seen that the Kansas species has its beaks more elevated, and placed nearer the anterior end; it is also a little broader shell, in proportion to its length, and rather straighter on the dorsal and ventral margins.

Locality and position.—Near the level of the Missouri River, at Leavenworth City, Kansas. Coal Measures. (Type 1019.)

Chænomya Cooperi.

(PLATE II, Fig. 2, *a*, *b*.)

Panopæa Cooperi, MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858, 11.

Allorisma? Cooperi, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 264.

Shell oblong subcylindrical; posterior side very abruptly truncated, a little oblique, and widely gaping; anterior side more compressed, and rather narrowly rounded. Base nearly straight along the middle and behind, rounding up in front; dorsal side concave, and not declining behind the beaks, sloping rather abruptly in front. Beaks depressed, incurved, contiguous, and located about half way between the middle and the anterior end. Inflected cardinal margin a little thickened within, so as to leave a deep narrow depression along the cardinal border, in casts of the interior. Surface (of internal casts) marked by small, rather obscure concentric ridges, which are most distinct and regular on the umbones, and gradually fade away on other parts of the shell. (Muscular and pallial impressions unknown.)

Length, 2.57 inches; height, 1.37 inch; convexity or breadth, 1.12 inch; breadth of posterior hiatus, 1 inch.

This species will be readily distinguished from the last, by its proportionally shorter form, and more distinctly truncated and shorter posterior side. Its beaks are also rather less prominent, and marked by finer and more distinct concentric ridges. It seems to be more nearly related to a species described from the Coal Measures of Kansas, by Prof. Swallow, under the name of *Allorisma? minnehaha*, though our specimen wants the oblique ridge mentioned in the description of that species. Should they prove identical, however, the specific name *Cooperi* will have to take precedence, as it was published nearly a month in advance of the issue of Prof. Swallow's description.

Locality and position.—Helena, Kansas Territory. Coal Measures. (Type 1018.)

CLASS GASTEROPODA.

SUB-CLASS PROSOBRANCHIATA.

ORDER Rhipidoglossata.

SUB-ORDER PODOPTALMA.

FAMILY PLEUROTOMARIIDÆ.

Shell varying in form, thickness and ornamentation, according to the genera and species; imperforate or more or less widely umbilicate, pearly within. Aperture not sinuous, or produced below. Outer lip with a

more or less deep marginal slit or sinus near the middle, at the termination of a revolving band usually seen on all the whorls; sinus sometimes closed, excepting at intervals, so as to leave a series of isolated openings in the revolving band.

The animal of the typical genus (*Pleurotomaria*) of this extensive and interesting family, now so nearly extinct, has not, we believe, been described. That of *Scissurella*, however, an existing genus apparently related to this family (though its shell is not pearly within), has been studied by Mr. Lucas Barrett, who describes it as follows: "Tentacles long, serrate, at the base of which are placed the eyes; foot furnished with two pointed lappets, and two long, slender, serrated cirrhi on each side. Operculum very thin, ovate, with an obscure, subspiral nucleus. No part of the animal was external to the shell. The only living specimen occurred at Hammerfest, in forty-six fathoms of water."

The family *Pleurotomariidæ* was represented during the Palæozoic and several later epochs, by a great number of beautiful shells, presenting elegantly sculptured surfaces. It seems to stand, as it were, between the *Trochidæ* and the *Haliotidæ*, though authors are not agreed in regard to its relations to these and some of the allied groups. It includes the genera *Pleurotomaria*, *Platyschisma*, *Scissurella*? *Murchisonia*, *Trochotoma*, and *Polytremaria*. The Palæozoic groups *Euomphalus* (as typified by such forms as *E. pentangulatus*, Sowerby), *Scalites*, *Raphistoma*, *Helicotoma*, and some undescribed genera from the older rocks, seem also to be related to this family.

Genus PLEUROTOMARIA, DEFRANCE.

Synon.—*Anatomus* [??], MONTFORT, Conch. Syst. II, 1810, p. 278.

Pleurotomaria, DEFRANCE, Dict. Sci. Nat. XLI, 1826, 381.—MENKE, Synon. 1828; and ib. 1830, 55.—DESHAYES, Encyc. Meth. III, tab. 1830; and ib. 1832; 789.

Etym.—πλευρα, side; τρεῖς, to cut.

Examp.—*Pleurotomaria Quoyana*, FISCHER.

Shell trochiform, or more or less conical, pearly within, and variable in thickness according to the species, with or without an umbilicus; volutions angular, flattened or rounded. Surface variously ornamented with striæ, nodes, granulations or carinæ. Aperture subquadrate, semi-oval, suborbicular or subrhombic; inner lip usually thin; fissure of outer lip generally narrow and deep; revolving band corresponding in breadth with the sinus.

The shells included in this genus are very similar in form, and the possession of a fissured lip, to those of the recent genus *Scissurella*, but differ in size and texture—all the known species of *Scissurella* being minute, non-perlaceous shells. The *Pleurotomarias* also closely resemble the genus *Anatomus*, of Montfort, from which Hermannsen and some others think they are not distinct. Other authors regard *Scissurella*, D'Orbigny, and *Anatomus*, of Montfort, as synonymous. Judging from Montfort's description of the genus *Anatomus*, however, it seems scarcely possible that it can be identical with *Scissurella*, since he distinctly states that the typical species of his genus is a pearly shell, and that the animal is without

eyes. From all the facts, it seems to be much more probable that *Anatomus* and *Pleurotomaria* are identical, than that either belong to the same genus as *Seissurella*. If they are synonymous, of course Montfort's name *Anatomus* must be adopted, since it has priority of date. Until their identity is more satisfactorily determined, however, we prefer to retain the name *Pleurotomaria*.

The founder of this genus divided it into two sections, one including the umbilicated species, with a rounded aperture, and the other those without an umbilicus. These sections have been regarded by other authors as distinct genera, but there are so many intermediate gradations connecting the umbilicate and imperforate species, that it is scarcely possible this can be regarded as a generic character. It is quite probable, however, that distinct genera have been confounded under the name *Pleurotomaria*, amongst the fossil species.¹

The genus *Pleurotomaria* was introduced at an early period, a number of species having been described from the Lower Silurian Rocks. It is also represented through the succeeding formations, and is particularly abundant in the Coal Measures of the Western States. It attained its greatest numerical development during the Jurassic epoch, and is well represented in the Cretaceous strata; since the deposition of which it has rapidly declined. At present but two living species are known, one of which occurs on the coast of Marie Galante, and the habitat of the other is unknown. Both of these species are very similar to some of those found in the Jurassic and Cretaceous rocks. The Palæozoic species, as might be expected, retain no traces of their original pearly lustre, though some of those found in the more modern rocks are still nacreous.

Pleurotomaria humerosa.

(PLATE I, Fig. 14, a, b.)

Pleurotomaria humerosa, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 262.

Shell turbate, or conical subovate; spire turreted, moderately elevated. Volutions five to five and a half, very convex, more or less obliquely flattened above, rounded below, and distinctly angular at the outer margin of the flattened upper side. Suture distinct; columella with a small shallow umbilical perforation. Surface ornamented by about ten rather strong revolving lines, only some three or four of which are visible on the upper whorls below the angle; on the flattened upper surface of the whorls there are five to seven additional, much smaller revolving striae, sometimes obsolete on worn specimens. Aperture suborbicular.

Length, 0.62 inch; breadth, 0.50 inch; apical angle about 62°.

None of the specimens of this species we have seen have the lip entire, and as the lines of growth are not preserved, it is impossible to determine the nature and position of the labial sinus and spiral band. From analogy, however, we would suppose the band to occupy a position just outside of the angle of the shoulder, and of course the sinus of the lip, in that case, would be near the point where it is intersected by this angle.

This shell seems to be rather closely allied to *Pleurotomaria Yvanii*, Leveille

¹ Hermannsen places *Ptychomphalus*, Agassiz (Germ. Trans. Sowerby's Min. Conch. 1837, 23, 222, 310), as a synonym of *Pleurotomaria*. We are not well enough acquainted, however, with the type of Prof. Agassiz's genus (*Helicina compressa*, of Sowerby, from the Lias), which we only know from an examination of Sowerby's imperfect figures, to express an opinion in regard to its relations.

(sp.), as figured by Koninck, on pl. 37 of his work on the Carboniferous Fossils of Belgium. It is considerably smaller, however, has one or two whorls less, and proportionally larger, and less numerous revolving lines below the shoulder; while those above are smaller in proportion to the breadth of the flattened upper side. It is also related to *P. subsinuata*, of Meek & Worthen (Proc. Acad. Nat. Sci. Phila. Oct. 1860), but has a more elevated spire, while the upper side of its whorls are more distinctly flattened, and shouldered.

Locality and position.—Grasshopper Creek, Northeastern Kansas. Coal Measures. (Type 1002.)

***Pleurotomaria subturbinata*.**

(PLATE I, Fig. 13.)

Pleurotomaria subturbinata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 264.

Shell small, comparatively thick, obliquely conical; spire moderately elevated, rather pointed at the apex. Volutions six to six and a half, convex, and angular in the middle, obliquely concave above, and having around the middle of the last, just below the angle, a rather narrow, shallow, revolving sulcus. Umbilical region a little depressed, and perforated by a very small pit; aperture suborbicular. Surface ornamented by small revolving lines (only preserved on the under and outer sides of the body whorl, in our specimen, which is somewhat worn and shows no lines of growth). Angle on the middle of the whorls apparently double, or composed of two parallel lines.

Length, 0.36 inch; breadth, 0.29 inch; spiral angle regular, divergence 69°.

We have seen no specimens of this species with the lip in a condition to show the nature and position of the sinus; nor are the lines of growth sufficiently well preserved to indicate the position of the spiral band. It is probable, however, from the appearance of the specimens, that the band is coincident with the sulcus below the angle on the middle of the body whorl.

Locality and position same as last. (Type 1003.)

CARBONIFEROUS AGE.

(PERMIAN PERIOD.)

MOLLUSCA.

CLASS LAMELLIBRANCHIATA.

FAMILY PECTINIDÆ.

Shell suborbicular, inequivalve, nearly or quite equilateral, very slightly oblique, and more or less distinctly auriculate; not nacreous, and without a prismatic structure. Hinge line straight; ligament marginal. Cartilage generally confined to an internal pit or groove under the beaks; sometimes occupying linear furrows in a cardinal area. Anterior margin of one valve more or less deeply notched, or sinuous, for the passage of the foot or byssus. Scar of the adductor muscle large, and subcentral; pallial line simple.

Animal with mantle freely open and provided with double margins, the inner one of which is fringed with pendent filaments, and the outer bounded by a row of distinct ocular dots, or rudimentary eyes. Palpi smooth externally, and pectinated on their inner sides; mouth surrounded by foliaceous leaflets. Gills equal, each pair partially folded upon itself. Foot small, cylindrical, grooved, forming a byssus while the animal is young. Sexes united.

The *Pectinidæ* are closely related to the *Spondylidæ*, which form a natural transition to the *Ostreidæ*. They differ, however, in the more regular form of the shell, and in never being attached by the substance of the valves. They also generally want the strong interlocking teeth of the typical *Spondylidæ*, and the animal differs in having a more developed foot and numerous ocular dots.

In order to include in this family some extinct forms apparently belonging here, it seems to be necessary to admit at least two distinct sub-families, distinguished as below:—

1. Pectininae.

Shell with anterior ear usually a little larger than the other; cartilage occupying an internal pit or groove under the beaks.

Includes the genera *Pecten*, *Vola*, *Camptonectes*, *Amussium*, *Syncyclonema*, *Hemipecten*, and many undescribed living and extinct genera.¹

¹ We have been informed by Prof. Agassiz that he has recently studied this family with much care, and that he finds it necessary to establish numerous new genera, which he has not yet published, making, with those already established, more than fifty distinct genera, living and extinct.

2. Aviculo-pectininae.

Shell with posterior ear generally larger than the other; hinge without a central cartilage pit; cartilage apparently occupying a series of linear furrows in a more or less broad cardinal area.

Includes *Aviculopecten*, *Streblopteria*, and probably several undefined Palaeozoic genera.

The *Aviculopecten* group seems to form a kind of transition from the *Pectinidae* to the *Pteriidae*, and may possibly be distinct from them both, though it is evidently more closely allied to the former than the latter. It seems to bear much the same relations to the typical forms of the *Pectinidae* that the *Pteriniinae* do to the typical *Pteriidae*.

SUBFAMILY AVICULOPECTININÆ.

Genus AVICULOPECTEN, McCoy.

Synon.—*Avicula*, *Pecten*, and *Meleagrina* (sp.), of various authors.

Aviculopecten, McCoy, Ann. Mag. Nat. Hist. VII, 1851, 171; Brit. Pal. Foss. 1852, 392.

Etym.—*Avicula* and *Pecten*.

Examp.—*Aviculopecten docens*, McCoy.¹

Animal unknown. Shell inequivalve, more or less inequilateral; straight, or slightly extended obliquely towards the posterior side; anterior ear flattened, smaller than the posterior, sharply and deeply defined, with a notch in the right valve between it and the body of the shell for the passage of the byssus;² posterior ear pointed, extending about as far as the margin of the shell, defined or not; ligament confined to a narrow³ facet along the hinge margin; no medial cartilage pit; muscular impression and pallial scar as in *Pecten*. (McCoy.)

We entirely concur with Prof. McCoy in separating this group of shells both from *Pteria* (= *Avicula*) and *Pecten*. From the typical species of the latter of these genera, they differ materially in having the cartilage extended along the hinge instead of occupying a mesial pit under the beaks; they also present the external difference of having the posterior ear larger than the other. From the *Pterias* they are clearly separated by their more equilateral and less oblique form, edentulous hinge, and the arrangement of the cartilage, as well as by their shell structure.

Some difference of opinion exists in regard to the family relations of this genus, several authors placing it in the *Aviculidae*, and others with the *Pectinidae*. We

¹ In first proposing this genus in the Annals and Mag. Nat. Hist. (VII, 1851, p. 171), Prof. McCoy does not say what species he regards as the type, though he figures, as an illustration of the genus, a species (without a name), which seems to be his *A. docens*; at any rate it is clearly congeneric with that form.

² Judging from Prof. McCoy's figures of Palaeozoic *Pectinidae*, in his Synopsis of the Carboniferous Fossils of Ireland, the byssal sinus would seem to be sometimes as strongly defined under the anterior ear of the *right*, as well as the *left* valve, in *Aviculopecten*; or there is another genus presenting that character.

³ Some of our American species have a broad cardinal area, marked with distinct cartilage furrows ranging parallel to the hinge line, or sometimes divaricately deflected under the beaks.

are decidedly of the opinion, however, that it is more nearly allied to the latter. It is true these shells have no internal cartilage pit, but we have ascertained that they have the shell structure of the *Pectinidæ*, and not that of the *Pteriidæ*.

The annexed cut shows the structure of *Aviculopecten amplus*, Meek & Worthen, as seen in a fragment placed in Canada balsam, under a magnifier of 350 diameters.¹



It will be seen that there is here no traces of the prismatic cellular structure of the *Pteriidæ*. The shell, on the contrary, is composed of very thin laminae, with striated or corrugated surfaces as in the *Pectinidæ*. These striae are not parallel on the different laminae, nor on the opposite sides of the same layer, but arranged so that on looking through several of these plates they are seen crossing each other at various angles. From this structure, therefore, taken in connection with the form and general appearance of these shells, it is manifest they belong to the *Pectinidæ*, or possibly to an intermediate group between that and the *Pteriidæ*.

This genus was probably introduced during the deposition of the Devonian rocks. It attained its maximum development during the Carboniferous epoch, and is also represented in the Permian rocks, the deposition of which it seems not to have survived.

Aviculopecten ————?

(PLATE II, Fig. 10.)

Comp. *Pecten cleavelandicus*, SWALLOW, Trans. Acad. St. Louis, I, Feb. 22, 1858, p. 182.

We are in doubt whether or not this shell is identical with Prof. Swallow's species cited above, and consequently prefer not to describe it as new, though we suspect it may prove to be distinct. It certainly does not appear to have presented the same proportions, judging from his measurements, which make the height and breadth of his species as 1.63 to 0.95; though we think there must be a typographical error in these figures, since *P. cleavelandicus* is described as being "orbicular." It would also seem to differ from our shell in being "oblique."

Locality and position.—Kansas; near Chapman's Creek, eighteen miles above Fort Riley. Permian beds.

Aviculopecten McCoyi.

(PLATE II, Fig. 9.)

Shell under medium size, broad subovate exclusive of the ears; not oblique, rounded on the ventral margin, and having a moderately deep, rounded sinus under each ear. Hinge margin sloping slightly from the beaks, and equalling about three-fourths the breadth of the widest part of the valves below. Left valve gibbous; umbo convex, its sides converging at an angle of about 85° to the apex; ears nearly equal, the posterior one being a little larger and more angular than the other. Anterior ear somewhat rounded at the extremity, separated from the swell of

¹ The lines are too straight and regular in this cut. Wood engraving is not well adapted to the illustration of such objects.

the umbo by an oblique, rather deep, rounded depression. Surface ornamented by simple, rounded, unequal radiating costæ, which are crossed by exceedingly fine, regular, closely-arranged concentric striæ, and a few stronger marks of growth.

Of the sixty or seventy radiating costæ seen on the left valve, some nine or ten occupy each ear—those on the anterior ear being a little coarser and more distinct than on the other. On the body part of the valve, about every fourth or sixth one of the costæ is a little larger than the others, and provided with a few distant, rather regularly disposed, vaulted, scale-like projections, which may, on well-preserved specimens, sometimes assume the character of short spines. Only the largest costæ extend quite to the apex of the beak, while another series nearly reaches it; a third series dies out from one-half to two-thirds of the way up from the border, and a fourth extends generally less than half way up.

Height, from the ventral margin to the hinge, 0.83 inch; breadth, or greatest transverse diameter, 0.75 inch; breadth of narrowest part just under the ears, 0.45 inch; length of hinge, 0.49 inch; convexity (of left valve), 0.22 inch.

This species may be distinguished from any of those resembling it in other respects, yet known to us from these rocks, by the rugose or subspinous character of its largest costæ, and its fine concentric striæ. It bears some resemblance to *A. segregatus*, McCoy (British Pal. Foss. pl. 3, E, fig. 1), but is a proportionally narrower shell, has a shorter hinge, and more slender costæ. It also probably differs in the possession of the fine concentric lines mentioned above, though Prof. McCoy's specimen was apparently not in a condition to have retained these, if it ever possessed them.

Named in honor of Prof. Frederic McCoy, of Dublin, Ireland, the author of the genus.

Locality and position.—South Cotton-Wood Creek, Kansas. Permian beds.

FAMILY PTERIIDÆ. (See page 27.)

SUBFAMILY PTERINIINÆ. (See page 28.)

Genus MYALINA, KONINCK. (See page 30.)

Myalina aviculoides.

(PLATE II, Fig. 8, a, b, c, d.)

Myalina aviculoides, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, p. 184.

Shell subtrigonal, higher than long, very convex, or subangular down the umbonal slopes; anterior margin distinctly sinuous above the middle, thence descending with a slightly convex curve, nearly at right angles with the hinge to the basal extremity, which is narrowly rounded. Posterior side compressed, its margin curving a little forward above, or intersecting the hinge at right angles; slightly convex and nearly perpendicular along the middle, below which it curves obliquely forward to the abruptly rounded basal extremity. Hinge straight, nearly equalling the length of the shell; beaks very convex, subangular, and curving rather abruptly forward, so as to become nearly or quite terminal. Surface having moderately distinct concentric marks of growth.

Length, 1.48 inch; height, 1.66 inch; convexity of a left valve, 0.32 inch.

This form may be readily distinguished from all the other species of the genus known to us, resembling it in other respects, by its peculiar sinuous, or arcuate front, and the extended or somewhat lobed character of its anterior margin under the beaks. Young or undeveloped individuals are generally longer than high, and have much more oblique umbonal slopes than adults. As the shell advanced in size, however, the umbonal ridges curved down so as to stand nearly at right angles to the hinge, and the valves became elongated in the same direction, so as to make the height greater than the length. Usually the anterior margins of the

valves below the most sinuous part are deflected from the umbonal slopes rather abruptly inwards, so as to meet at an obtuse angle, or sometimes almost on the same plane.

Locality and position.—Cotton-Wood Creek, Kansas, south of Kansas River. Permian beds. (Type 3961.)

Myalina permiana.

(PLATE II, Fig. 7, a, b, c.)

Mytilus (Myalina) permianus, SWALLOW, Trans. St. Louis Acad. Sci. Vol. I, March 8, 1858, 17.

Mytilus (Myalina?) concavus, SWALLOW, ib. 18.

Shell obliquely subovate, or subtrigonal; convex anteriorly, and cuneate behind; beaks terminal, rather pointed, and directed nearly horizontally forward at the points. Umbonal slopes prominent from the beaks down along the front of the valves. Hinge straight, generally more than equalling half the greatest length of the shell, and ranging at an angle of 60° to 65° with the oblique anterior margin; cardinal area of moderate breadth, and distinctly striate. Posterior margin rounding down with a broad sweep from the posterior extremity of the hinge, to the abruptly rounded antero-ventral extremity; anterior margin concave, or more or less arcuate in outline from the beaks to the base, and very abruptly inflected from the prominent umbonal ridge of each valve. Surface marked by obscure concentric striæ, or nearly smooth.

Length, from the beaks to the antero-basal extremity, 1.75 inch; length of hinge, 1.08 inch; breadth, 0.96 inch; convexity, about 0.70.

Prof. Swallow's descriptions of the two forms cited above, agree so nearly with the specimens before us, that we can scarcely entertain a doubt in regard to their identity, especially when we bear in mind that they came from the same beds, at near the same locality. Our specimens also show various gradations between the shorter and more elongate forms, so that we cannot believe a specific distinction can be based upon these differences.

This species is evidently very closely allied to a shell described by Dr. Isaac Lea, of Philadelphia, from the Coal Measures of Pennsylvania, under the name of *Modiola wyomingensis* (Jour. Acad. Nat. Sci. Phila. vol. II, 2d ser. p. 205, pl. xx, fig. 1). Dr. Lea's figure seems to represent a slightly more oblique shell, with a little longer hinge; but as the species before us is variable in these characters, we are prepared to believe the Kansas and Pennsylvania shells may possibly prove to belong to the same species. If so, Dr. Lea's specific name will have to be adopted, since his paper was published in 1852.

The species under description may be distinguished from our *M. perattenuata*, by its more robust appearance, broader form, and less attenuate beaks. It is probably also a thicker shell than *M. perattenuata*, though our specimens being all cast, we are not sure this is the case.

Locality and position.—From Permian beds near the Smoky Hill fork of Kansas River; on Cotton-Wood Creek, and at many other localities south of Kansas and Smoky Hill River, in northeastern Kansas. We think we have also seen it in the Coal Measures below, in the same region. (Type 1153.)

SUBFAMILY PTERIINÆ. (See page 28.)

Genus EUMICROTIS, MEEK.

Synon.—*Gryphites* (sp.), SCHLOT. Acad. Munch. 1816, 30; ib. Petref. 1820, 292.

Avicula (sp.), J. DE C. SOWERBY, Trans. Geol. Soc. Lond. 2d ser. III, 1829, 119, and of various others (not KLEIN; LAMK.).

Monotis, KING, Catalogue Perm. Foss. 1849, p. 9; id. Monogr. Perm. Foss. Great Brit. 1850, p. 154.—MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858.—SWALLOW, Trans. St. Louis Acad. Sci. I, 1858.—SHUMARD, ib. 1859 (not BRONN, 1830).

Eumicrotis, MEEK, American Jour. Sci. 2d ser. XXXVII, March, 1864, p. 216.

Etym.—*eu*, very; *μικρ*, small; *otis*, ear.

Type.—*Monotis Hawni*, MEEK & HAYDEN.

Shell suborbicular, plano-convex, the left valve being usually very convex, and the right flat, or even a little concave; not distinctly auriculate, the ears being nearly obsolete. Beaks sub-central, very slightly oblique, unequal, that of the left valve often elevated, gibbous and incurved; the other very small, and scarcely projecting above the hinge line. Hinge short, narrow, edentulous; cartilage cavity under the beaks (King). Byssal notch or sinus of right valve narrow, deep, and separated from the hinge by a very small rudimentary ear, which does not project beyond the margin. Adductor muscular scar large and sub-central, impressions of retractor muscles several, small and placed near the beaks. Surface generally with radiating, more or less vaulted or scaly costæ, much more distinctly marked on the left than the right valve.

The shells embraced in this genus are apparently most nearly allied to *Aucella* of Keyserling, to which Prof. McCoy refers them. Although Count Keyserling's genus has not been generally adopted, it seems to be entirely distinct from all the allied groups, and has been clearly defined by its distinguished author. All the species upon which it was founded, however, differ from those of the group under consideration, in being much more oblique, more oval in form, and entirely destitute of any traces of radiating costæ or striæ; while they are all marked with more or less distinct and regular concentric costæ or undulations, as in *Inoceramus*. Again, they have the right or smaller valve proportionally more ventricose than in *Eumicrotis*, and also possess a minute, internally concave, sharply defined anterior ear under the beak of the left valve, never seen in the group we are describing. Another difference is the entire absence of the lobed appearance of the posterior side of the valves in *Aucella*, so often seen in the typical forms of *Eumicrotis*. In addition to these differences, Count Keyserling's figures (*Petschora Land*, tab. 16) show that in the type of his genus the scar of the adductor muscle is nearly marginal; and that there is no distinct cartilage cavity under the beaks; while according to Prof. King, there is in *E. speluncaria*, Schlot. (sp.).

That the group of shells we are describing are not congeneric with *Monotis* of Bronn, must be manifest to any one who will take the trouble to compare one of these forms with *Monotis salinaria*, the type of Bronn's genus. This shell, it will

be observed, differs from all of those included in the genus *Eumicrotis*, in being more oval in outline, more compressed, more oblique, and very nearly if not quite equi-valve; while very little difference can be seen between the prominence of its right and left beaks. Its most important peculiarity, however, is the total absence of any traces of a byssal notch or sinus in the anterior margin of either valve.

The typical forms of the genus *Eumicrotis* are, so far as known, confined to the Permian rocks in Europe, and to the Permian and upper Carboniferous of America. In addition to the type—*E. Hawni*, M. & H.—this genus includes *E. speluncaria*, Schlot. (sp.), *E. radiatus*, Phillips (sp.), *E. Garforthensis*, King (sp.); and *E. Halli* and *E. variabilis*, Swallow (sp.).¹

A small section of this group, of which *Avicula substriata* of Munster is an example, seems to be mainly confined to the Jurassic rocks, though it may also be represented in the Trias. These shells should probably rank as a distinct subgenus, though with our present means of comparison we are not fully satisfied that this is the case.

Some Palæontologists will insist upon referring to the genus *Pteria* (*Avicula*), all such forms as those included in the groups above characterized. A moment's comparison, however, of these shells with the recent typical forms of that genus, can scarcely fail to convince any skilful Conchologist that such a mingling of types is totally inadmissible in our present advanced state of Natural History.

Eumicrotis Hawni.

(PLATE II, Fig. 5, a, b, c.)

Monotis Hawni, MEEK & HAYDEN, TRANS. ALBANY INST. IV, MARCH 2d, 1858.

Monotis speluncaria, var. *americana*, SWALLOW, TRANS. ST. LOUIS ACAD. SCI. I, 184.

Monotus speluncaria, SHUMARD? 1859, TRANS. ST. LOUIS ACAD. SCI. I, 396 (non SCHLOT.).

Eumicrotis Hawni, (M. & H.) MEEK, AM. JOUR. SCI. XXXVII, MARCH, 1864, 216.

Shell subcircular, or subovate; hinge straight, equalling about half the length of the valves; beaks sub-central, short, not oblique; ears nearly obsolete; base rounded, antero-ventral and postero-ventral margins rounded, the

¹ Prof. King suggests that the genus including *E. speluncaria* probably belongs more properly to the *Pectenidæ* than to the *Aviculidæ*, since Mr. Carpenter had found that *Avicula cygnipes* of Phillips, supposed to be congeneric with *E. speluncaria*, presents the microscopic structure of the *Pectenidæ*, and not that of the *Pteriidæ*. We think, however, that it is very improbable that these two shells can be congeneric, for we find our *E. Hawni*, which is even specifically very closely allied to, and certainly congeneric with, *E. speluncaria*, shows very distinctly, under a high magnifying power, the prismatic structure of the *Pteriidæ*. The annexed cut, No. 1, represents the structure of this species as seen

No. 1.



Shell structure of *E. Hawni*.

No. 2.



Shell structure of *E. curta*.

by transmitted light, when magnified about 300 diameters. We also observed the same structure in the Jurassic species *Eumicrotis curta*, Hall (sp.), as may be seen by the annexed cut, No. 2.

In regard to the relations of *Avicula cygnipes*, of Phillips, to *Monotis salinaria*, Bronn, we would merely state that we differ widely from those who would place two such shells in the same genus.

latter being somewhat more prominent than the other. Left valve convex; anterior margin sometimes slightly sinuous near the hinge above; posterior margin intersecting the hinge at an obtuse angle; beak convex, extending but slightly beyond the hinge line. Right valve nearly or quite flat; beak flat, not projecting beyond the hinge; byssal sinus narrow, deep, or extending back parallel to the hinge to a point nearly under the beak.

Surface of both valves, particularly the left one, ornamented with more or less distinct radiating costæ, which are usually separated by spaces three or four times their own breadth, and armed with regularly disposed vaulted, spine-like prominences, formed apparently by the projecting laminae of growth. Between each two of the principal costæ from one to three or four much smaller radiating ribs or lines are usually seen, crossed by obscure concentric markings. (Hinge and muscular impressions unknown.)

Length, 1.47 inch; height, 1.42 inch; convexity, about 0.40 inch.

In first describing this species, we called attention to its close relations to *E. speluncaria*, Schlot. (sp.), and stated that we were aware it would not be easy always to find characteristic differences by which certain varieties of these two forms could be distinguished. Every naturalist, however, must have met with analogous cases, where the varieties of two closely allied, but variable species approximate, and, as it were, mingle together, so as to render it sometimes extremely difficult to separate them; while the normal forms of each are so clearly distinct as to leave no doubt on the mind that they belong to different species. This, we think, is the relations the Kansas shells bear to *E. speluncaria*, although we are aware some of our friends entertain the opinion that they are not specifically distinct.

It is true, some specimens agree almost exactly with such varieties of *E. speluncaria* as are represented by figures 15, 17, 20 and 21, pl. xiii, of King's work on the Permian Fossils of England; yet out of hundreds of individuals, collected and seen by us in Kansas, we have never met with one presenting the peculiar lobed and sulcated posterior, so characteristic of the well developed normal forms of *E. speluncaria*, such, for instance, as figures 5, 6, 7, 8, 9, 10 and 11 of plate xiii, in King's work cited above. Again, none of our Kansas specimens, with a solitary exception, has the beak of the right valve so gibbous, or near so elevated, as those represented by the figures last above cited; and in this single exception, the shell differs so widely in other respects, that if not a monstrosity, we can but regard it as belonging to a distinct species from that under consideration, as well as from *E. speluncaria*.

Locality and position.—Near the mouth of Smoky Hill fork of Kansas River, and at several places on the high country between there and Council Grove, as well as on Cotton-Wood Creek, Kansas. Permian. (Type 3958.)

***Eumicrotis Hawni*, var. *ovata*.**

(PLATE II, Fig. 5, a, b.)

This variety differs from the typical forms of *M. Hawni*, in being more compressed, and more ovate in outline, its diameter from the hinge to the ventral margin being proportionally greater; while its hinge margin is much shorter, or not more than equalling about one-third, instead of one-half, the greatest breadth of the valves. Its costæ are also usually more distinctly defined, and its beak rather more pointed. In some respects it resembles *M. Garforthensis*, King, but its costæ are not so uniform, nor so spinous. We are inclined to think it will prove to be specifically distinct from *E. Hawni*; but as we are not clearly satisfied that this is the case, we merely name it for the present as a variety of that species.

Diameter, from hinge to ventral margin, 1.54 inch; breadth, 1.43 inch; convexity of left valve, 0.28 inch.

Locality and position.—Near Cotton-Wood Creek, south of the Santa Fé Road, Kansas. Permian. (Type 1157.)

SUBFAMILY MELININÆ. (See page 28.)

Genus BAKEVELLIA, KING.

Synon.—*Mytilites* (sp.), SCHLOT. Akad. Munch. VI, 1816, 30; ib. Petref. 1820, 293.

Avicula (sp.), J. DR C. SOWERBY, Trans. Geol. Soc. 2d ser. III, 1829, 119.—GOLDF. Petref. 2d part, 1826, 126, and of several others (not [KLEIN] LAMK.).

Bakevellia, KING, Catalogue, 1848, 10.

Gervillia, GEINITZ, Versteinerungen, 1848, 10; ib. Dyas, 1862 (not DEFRANCE, 1820).

Etyim.—Dedicated to Robert Bakewell, of Hampstead, England.

Type.—*Avicula antiqua*, MUNSTER.

Shell more or less aviculiform, subequivalve; valves somewhat sinuous and a little gaping in front for the passage of the byssus. Umbones depressed and oblique. Surface with concentric striæ. Hinge provided with a few linear anterior and posterior lateral teeth, arranged nearly or quite parallel to the cardinal margin. Muscular scars much as in *Pteria* (*Avicula*), excepting that the anterior one is larger and more distinct. Cardinal area usually well developed in both valves; cartilage furrows distinct, two to five in each valve.

Animal unknown.

In form, as well as in the possession of a more or less developed anterior and posterior wing, and the inequality of the valves, the species of this genus are often very similar to *Pteria*; from which, however, they differ in the possession of a large, deeply grooved cardinal area, and a divided cartilage, as well as in the nature of the hinge teeth, and the proportionally larger size of the anterior muscular impression.

In the possession of a broad cardinal area, crossed by a few deep furrows for the reception of the cartilage, the *Bakevellias* seem to present affinities to the genus *Gervillia*, which some of the species closely resemble in form. The nature of the hinge, however, and the greater development of the anterior muscular scar, clearly separate them from that group, at least generically.

Prof. King, the able author of the excellent Monograph of the Permian Fossils of England, thinks the comparatively large size of the anterior muscular impression in this genus, sufficiently marked, not only to separate it from *Pteria*, but to remove it entirely from the *Pteriidae*. Still in the rather low, or nearly sub-central position of the posterior muscular impression, when taken in connection with the general similarity of these shells to *Pteria* and *Gervillia*, they seem to present a combination of characters bringing them very near, if not within the *Pteriidae*.

In Europe, the genus *Bakevellia* is generally regarded as being restricted to the Permian System. If the following described species, however, really belongs to this genus, it would seem to have been introduced at a somewhat earlier period here, since we have seen it in Kansas in beds we regard as probably of the age of the Coal Measures, though it ranges up, and is most abundant in the Permian beds above.

Bakevellia parva.

(PLATE II, Fig. 12, a, b.)

Bakevellia parva, MEEK & HAYDEN, TRANS. ALBANY INST. IV, March 2d, 1858.

Shell very small, obliquely subovate, oblong, or subrhombic in outline; valves gibbous along the oblique umbonal slopes. Antero-ventral margin sloping very obliquely backwards and downwards; rather distinctly sinuous under the beaks. Postero-basal extremity rounded; anal edge sinuous above; anterior extremity somewhat lobed, sub-angular or very narrowly rounded. Hinge line straight, nearly or quite equalling the greatest length of the shell, and ranging at an angle of about 35° to the umbonal prominences. Beaks rather small, rising a little above the hinge, incurved, and located about half way between the middle and the anterior extremity. Postero-dorsal region compressed, or more or less alate, and terminating at a distinct angle at the extremity of the hinge. Surface with concentric striae. Anterior teeth of hinge, one or two to each valve, linear and declining a little in front; posterior teeth, one or two, long, linear and ranging parallel to the hinge margin.

Length, 0.20 inch; height, 0.10 inch; thickness or convexity of the valves, about 0.08 inch.

We can scarcely regard it as a clearly established fact that this little shell possesses all the characters of Prof. King's genus *Bakevellia*, since its cardinal area and muscular and pallial impressions have not yet been seen. It agrees, however, so exactly in form and general appearance, as well as in the nature and arrangement of its hinge teeth with that genus, and differs so materially in the latter character and the absence of a byssal sinus from *Pteria*, that we do not feel warranted in removing it from the genus in which we first provisionally placed it.

It agrees very nearly in form with some varieties of *Bakevellia antiqua*, Munster (sp.), but is uniformly much smaller—never being more than one-fourth the average size of that shell; while its cardinal area must be much narrower, judging from the close proximity of the beaks; the posterior extremity of its hinge is also much more angular.

Locality and position.—Near the mouth of Smoky Hill fork of Kansas River; on Cotton-Wood Creek, and at numerous other localities in northeastern Kansas; in beds of yellowish magnesian limestone of Permian Age. (Type 3959.)

FAMILY TRIGONIIDÆ.

Shell equivalve, generally inequilateral, closed, varying greatly in form and ornamentation, according to the several genera and smaller groups, nacreous within. Ligament external; hinge composed of a few diverging, usually large, interlocking teeth.

Animal with two recumbent gills on each side; palpi simple; mantle open; foot long, lanceolate, bent, and formed for leaping.

This family includes the following genera: *Schizodus*, *Myophoria*, *Trigonia*, and *Verticordia*? The first two of these genera are entirely extinct, while the *Trigonia*s, which were most abundant during the Jurassic and Cretaceous epochs, are still represented by a few living species. Of the genus *Verticordia*, only one or two Tertiary species, and one living species are known.

In tracing the different groups of this family, from its first appearance in the Palæozoic rocks, as plain shells (*Schizodus*) with smooth weak hinge teeth, it is

exceedingly interesting to see how gradually they shade off through the smooth, subplicate, and plicate *Myophorias* of the Trias, with their more developed hinge, into the highly ornate Jurassic, Cretaceous, and living *Trigonias*, with their still more complex dental system.

Genus SCHIZODUS, KING.

- Synon.*—*Tellinites* (sp.), SCHLOT. Akad. Münch. VI, 1816, 31.
Azinus (*obscurus*), SOWERBY, Min. Con. IV, 1821, 12.
Isocardia (*axiniformis*), PHILLIPS, Geol. York. 1836, 209.
Cucullæa (*Schlotheimi*), GEINITZ, Neues Jahrb. 1841, 638.
Donax? (*sulcatus*), J. DE C. SOWERBY, Geol. Tr. V, 1840, 491.
Sedgwickia (*gigantea*), MCCOY? Carb. Foss. Ireland, 1844, 62.
*Dolabra*¹ (part), MCCOY, Carb. Foss. Ireland, 1844, 64.
Myophoria, MCCOY, 1855, Palæozoic Foss. Great Brit. 1855, 494 (not BRONN, 1855).
Schizodus, KING, Ann. Mag. Nat. Hist. XIV, 1844, 313.

Etym.—σχίζω, I split; ὀδών, a tooth.

Type.—*Schizodus truncatus*, KING.

Shell more or less oval or subtrigonal; anterior side rounded and shorter than the other; posterior side tapering, more or less truncate at the extremity, and usually having an umbonal ridge extending from the beaks to the postero-basal margin. Beaks generally prominent. Surface smooth, or ornamented with concentric striæ. Hinge with two smooth cardinal teeth in the right valve, and three in the left; the middle tooth of the left valve being more or less bifid, and fitting between the two of the opposite valve. Free margins smooth.

Animal unknown.

As pointed out by Prof. King, this genus is closely related to *Myophoria*, of Bronn. Prof. McCoy has also subsequently expressed the opinion that the slight differences observable between the teeth of the hinge in these two groups are not of generic value, and ranges the species under Bronn's name *Myophoria*.² As we have had no opportunity to examine specimens showing the hinge, we merely retain provisionally, the name proposed by Prof. King. We would remark, however, that so far as we can judge from figures alone, we are inclined to think that the non-plicated Carboniferous and Permian species, with possibly a few of the similar forms from the Triassic rocks, should be retained under Prof. King's name, either as a distinct genus, or as a subgenus under *Myophoria*.

Prof. King has also called attention to the close relations between these two groups and the genus *Trigonia*; the principal difference between them, so far as the hinge is concerned, being the greater development, and sulcated character of

¹ As proposed by McCoy, the genus *Dolabra* was made to include species belonging to two distinct families. The first or typical species, *Cucullæa angusta*, Sw., and three others included by McCoy, constitute the genus *Dolabra* as properly restricted, by the separation of the species upon which Prof. King founded the genus *Schizodus*. As thus restricted, the genus *Dolabra* belongs to the *Arcidæ*, and seems to be closely allied to *Cucullæa*, Lamk. *Dolabra*? *alpina*, Hall, Iowa Report, I, part 2, p. 716, pl. xxix, fig. 2, is a true *Schizodus*, and its name should be *Schizodus alpinus*.

² British Pal. Foss. p. 494.

the teeth in the latter group. Externally, the differences between the Trigonias, and the plicated, or costated species of *Myophoria*, are about as great as those between the latter and the smooth typical species of *Schizodus*.

The genus *Schizodus*, as above defined, was probably introduced during the deposition of the Upper Silurian rocks.¹ It also occurs in the Devonian,² and is most common in the Carboniferous and Permian deposits. If any of the species included in the genus *Myophoria*, by Bronn, belong to this group, it must have been represented during the Triassic epoch.

Schizodus ovatus.

(PLATE II, Fig. 11, a, b.)

Axinus (*Schizodus*) *ovatus*, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1858, 262.

Comp. *Schizodus truncatus*, King, Permian Fossils England, p. 193, pl. xv, fig. 25 to 29, inclusive.

Shell longitudinally ovate, moderately convex, the most gibbous portion of the valves being slightly in advance of the middle. Anterior side broader than the other, but somewhat narrowly rounded; posterior side more contracted—compressed and obliquely truncated above, and subangular below; base forming a regular semi-ovate curve, the most prominent part of which is in advance of the middle. Cardinal margin short, straight, and intersecting the obliquely truncated posterior edge at an angle of about 130°. Beaks rather elevated, incurved at right angles to the hinge, and placed a little in front of the middle; posterior umbonal slopes prominently rounded, or subangular from the beaks to the postero-basal extremity. (Surface, muscular, and pallial impressions unknown.) Length, 0.65 inch; height, 0.45 inch; convexity, 0.32 inch.

This species is very closely related to *S. truncatus* of King, and may possibly prove to be identical, when a direct comparison of specimens can be made. It is more nearly like his fig. 27, pl. xv (Permian Fossils) than any of the other varieties represented by him, but differs in being more sharply rounded in front, while its beaks are a little more depressed. Its posterior umbonal slopes appear also to be less prominent than in any of his figures of *S. truncatus*.

Locality and position.—South Cotton-Wood Creek, Kansas; in Permian magnesian limestone. It also occurs there in lower beds containing many Coal Measure species. (Type 3960.)

FAMILY NUCULANIDÆ.

Shell longer than high, subovate, oblong or subelliptical, equivalve, usually somewhat pearly within; hinge provided with small interlocking cardinal plates or denticles, as in the *Nuculidæ*; ligament internal or external; margins of valves smooth within; pallial line more or less sinuous.

Animal with mantle margins open, fringed, and usually provided with ventral lobes; labial palpi very long, convoluted; siphons rather long, slender, partly united and retractile; gills plumose, attached throughout their length. Foot deeply grooved, geniculate, and usually with serrated margins.

¹ *Anodontopsis securiformis*, of McCoy, is apparently an Upper Silurian example of this genus.

² Murchison, Verneuil, and Keyserling refer to this genus, a species (*S. devonicus*) from the Devonian Rocks of Russia.

This group has been divided by Conchologists into two subfamilies, as follows:—

1. Nuculaninæ.

Shell pearly within; ligament internal.
Including *Nuculana* and *Yoldia*.

2. Malletinæ.

Shell with ligament external; valves sometimes slightly pearly within.
Includes *Malletia* and *Neilo*.

SUBFAMILY NUCULANINÆ.

Genus YOLDIA, MÖLLER.

Yoldia, H. P. C. MÖLLER, Krøyer's Nat. Tid. 1842, IV, 91; Ind. Moll. Græn. 18; Cf. Zeitschr. f. Mal. 1844, 12.

Synon.—*Maldia*, GRAY (misprint), 1847. *Leda* and *Nucula* (sp.), of various authors.

Etym.—Dedicated to the Countess Yoldi.

Examp.—*Nucula limatula*, SAY.

Shell ovate or subelliptical, subequilateral, more or less compressed; posterior side narrower than the other. Surface smooth, striate or obliquely sculptured, and covered with a polished epidermis. Margins smooth within; inner laminae slightly pearly. Hinge plaits small, and more or less numerous on each side of the beaks; cartilage occupying a pit under the beaks. Pallial line distinctly sinuous.

The genus *Yoldia* is closely allied to *Nuculana*, but may be distinguished by its deeper pallial sinus, and usually less prominent beaks. From *Nucula*, which it resembles in the crenulated character of the hinge, it will be readily distinguished, not only by the presence of a sinus in the pallial line, but by its less distinctly nacreous, and differently formed shell. The animals in these two genera are also different.

We are not sure this genus dates back to the Palæozoic epoch, though some of the Carboniferous and Permian species present exactly the form and external appearance of true Yoldias. Some of the Triassic and Jurassic species usually referred to the closely allied genus *Nuculana* (= *Leda*), probably also belong to this genus. Several of the Cretaceous species, figured by D'Orbigny in the Palæontology of France, under the names *Nucula* and *Leda*, seem to be typical Yoldias.

The genus *Yoldia* was represented by a few species during the Tertiary epoch, and probably attains its greatest development in the existing seas. The recent species are chiefly found in northern and antarctic seas, and occur on the coast of Greenland, Kamtschatka, Massachusetts, &c.

Yoldia ? subscitula.

(PLATE II, Fig. 4, *a*, *b*.)

Leda subscitula, MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858.

Shell of medium size, rather narrow subovate, moderately convex in the central and umbonal regions. Posterior half more compressed and subrostrate, very narrowly rounded at the extremity; anterior extremity less narrowly rounded. Base forming a broad semi-ovate curve, the most convex part of which is slightly in advance of the middle; dorsal outline convex, and declining a little in front of the beaks, somewhat concave and nearly horizontal behind them. Beaks moderately prominent, and nearly central. Hinge straight or sloping slightly from the beaks, near which a few fine crenulations are visible in the cast.

Length, 0.50 inch; height, 0.26 inch; breadth or convexity, about 0.17 inch.

The only specimens of this species we have seen, are internal casts, which give no idea of the surface markings. We have also been unable to make out the nature of the muscular and pallial impressions, and have therefore only placed it in this genus from the close analogy of its form to typical species in more recent formations.

Locality and position.—Near the mouth of Smoky Hill fork of Kansas River, and on Cotton-Wood Creek, as well as at other localities in the Permian beds of northeastern Kansas. (Type 3957.)

FAMILY CRASSATELLIDÆ. (See page 34.)

Genus PLEUROPHORUS, KING, 1844. (See page 34.)

Pleurophorus? subcuneatus.

(PLATE II, Fig. 3.)

Pleurophorus subcuneatus, MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858.

Pleurophorus? subcuneatus, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. June, 1859, 29.

Shell small, longitudinally oblong, the basal and cardinal margins being parallel, and the extremities rather narrowly rounded; valves moderately convex; beaks depressed, and located near the anterior end. Hinge long, straight, or slightly arched; cardinal teeth unknown; posterior lateral teeth parallel to the hinge margin, and remote from the cardinal teeth. Impression of the anterior adductor muscle deep, subtrigonal, and located close to the margin—internal ridge on its posterior side well defined, ranging nearly vertically; impression of the pedal muscle distinct from, and located directly over, that of the anterior adductor; posterior muscular impression very faint. Surface with fine concentric striae.

Length of a medium sized specimen, 0.54 inch; height, 0.24 inch; thickness or convexity, 0.16 inch.

In form and general appearance, as well as in the character and position of its anterior adductor muscular scars, and its posterior lateral teeth, internal ridge, &c., this species agrees quite well with the typical species of Prof. King's group *Pleurophorus*. It differs, however, in having the scar of its anterior pedal muscle nearly marginal, instead of farther back, while the casts show scarcely any traces of the radiating costæ generally well marked on those of that genus.

It also agrees very closely with a small shell figured by J. de C. Sowerby, under the name of *Unio phaseolus* (Trans. Geol. Soc. Lond. 2d ser. vol. V, p. 491), and subsequently referred, by Prof. Koninck, to the genus *Cardinia*. Indeed these shells are so closely similar, that, judging from the figures and descriptions we have seen of the European form, we have some doubts whether they may not prove to be specifically identical. We think it scarcely possible that they can belong to different genera. Possibly both should be referred to *Carbonocola*, McCoy (= *Anthracosia*, King).

This species will be known from our *P. occidentalis*, by its greater height in the anterior region, and more prominent antero-ventral border. It also seems to differ in being, as above stated, nearly or quite destitute of the radiating plications seen on that shell.

Locality and position.—Near the mouth of Smoky Hill fork of Kansas River; at the head of Cotton-Wood Creek, and at numerous other localities in north-eastern Kansas. From layers of yellow Magnesian Limestone of Permian age. (Type 4181.)

Pleurophorus? Calhouni.

(PLATE II, Fig. 13, a, b.)

Edmondia? Calhouni, MEEK & HAYDEN, Trans. Albany Inst. IV, March 2d, 1858.

Shell longitudinally subovate, gibbous over the oblique umbonal slopes. Extremities rather narrowly rounded; base forming a broad semi-elliptic curve, sometimes nearly straight along the middle; dorsal side declining rather gradually from the beaks posteriorly, and more abruptly in front. Hinge straight, apparently thickened within, so as to leave on internal casts a slightly impressed lanceolate area, along the cardinal region behind the beaks. Umbones moderately prominent, oblique, and placed a little nearer the anterior extremity than the middle. Anterior adductor muscular impression rather deep, broad ovate, and located near the buccal edge; scar of the pedal muscle small, oval, deep, and located near the margin of each valve, a little above the impression of the anterior adductor. Posterior muscular impression shallow; pallial line rather distinct (and undoubtedly simple).

Length (of an internal cast), 1.45 inch; height, 0.75 inch; convexity, 0.80 inch.

Since first referring this species with doubt to the genus *Edmondia*, we have satisfied ourselves that it cannot be retained in that genus; there being no traces left in well preserved internal casts, of the cardinal appendages for the attachment of the cartilage, as in *Edmondia*. Although we now place it provisionally in the genus *Pleurophorus*, we are not clearly satisfied in regard to its relations to that group; indeed, so far as we can determine from impressions of the hinge left in the matrix, it does not appear to have been exactly like that of the typical species of that genus.

This species may be at once distinguished from the last, by its larger size, proportionally shorter form, and less prominent internal ridge just behind the anterior adductor scar—as well as by its more prominent umbones, which are also placed farther back.

Locality and position same as last. (Type 4184.)

CEPHALOPODA.

ORDER **Tetrabranchiata.**

FAMILY NAUTILIDÆ.

Shell curved, involute, or rarely spiral; outer or last chamber capacious, sometimes deflected from the curve of the inner whorls, and more or less straightened; aperture usually sinuous on the dorsal or outer side. Septa simple, or with a few undivided lateral lobes or flexures; concave on the side facing the aperture. Siphon varying in its position between the inner and outer, or dorsal and ventral margins, according to the genera and species; rarely (in older extinct groups) occupied by an internal organic deposit; nearly always piercing the septa backwards from the aperture; envelope usually solid and persistent.

For what is known in regard to the structure of the animal in the recent typical genus of this family, we are mainly indebted to Prof. Richard Owen, of London. According to this distinguished comparative anatomist, the powerful parrot-like mandibles of the recent *Nautilus pompilus* are surrounded by a fleshy lip, around which are four groups of labial tentacles, numbering twelve to thirteen each. Outside of these, on each side of the head, are thirty-six brachial tentacles or arms, arranged in a double series; the dorsal pair being expanded and connected so as to form a hood, which partly closes the aperture of the shell when the other appendages are retracted. The tentacles are laminated on their inner sides, and capable of being drawn within sheaths apparently homologous with the eight arms of the Cuttle-fish. There are also four ocular tentacles—one behind and one before each eye. The respiratory funnel is formed by the folding of a thick lobe which extends laterally on each side of the head, with the free edge directed backwards into the branchial cavity. The mantle is firm and muscular as far back as the line of the shell muscles, beyond which it is transparent. Its margin is entire, and extends to the edge of the shell. The siphon is vascular, and connected with the pericardium.

Most Palæontologists include in the family *Nautilidæ*, an extensive group of older fossil shells presenting a great diversity of forms and other characters: such, for instance, as *Phragmoceras*, *Gomphoceras*, *Endoceras*, *Orthoceras*, *Huronina*, *Aploceras*, &c.—probably belonging to one or more distinct families. As here defined, the family *Nautilidæ* is intended to include the following groups: *Nautilus*,

Discites, *Trematodiscus*, *Temnocheilus*,¹ *Northoceras*, *Pteronutilus*,² *Lituities*? *Hortolus*? *Cryptoceras*, *Clymenia*, *Subclymenia*, *Aganides* (= *Aturia*), *Nautiloceras*, *Aploceras*, and *Trochoceras*, with probably some undescribed Jurassic, Triassic and older genera.

GENUS NAUTILUS, LINNÆUS.

Synon.—*Nautilus*, BREYNIUS, Dissert. Polyth. 1732, 12–14.—LINN. (part), Syst. Nat. ed. 10, 1758, t. i, 709.—BRUG. Encyc. Meth. I, 1789, p. xvi.—LAMK. Prodr. 1799, 79; and Syst. 1801, 99.
Oceanus, MONTF. Conch. Syst. 1808, p. 58–9.
Ammonites, Ib. 74–5, not (BREYN.—LINNÆUS).
Ellipsolites (sp.), SOWERBY, Min. Conch. I, 1814, 56 (not MONTF. 1808).
Omphalia and *Nautilus*, DE HANN, Mon. Amm. 1824.
Simplegas (sp.), BLAINVILLE, Dict. Sci. Nat. tom. 32, 185 (not *Simplegades*, MONTF. 1808).

Ety.—*ναυτιλος*, a sailor or navigator.

Type.—*N. pompilius*, LINN.³, LINN.

Shell subglobose or more or less compressed; umbilicus closed or open; volutions coiled in the same plane, merely contiguous, or more or less deeply embracing. Septa simple or somewhat arched or waved on the lateral margins; siphon generally central or subcentral. Surface smooth or variously striate or costate and furrowed; in some of the older extinct species ornamented with nodes. Lip generally more or less sinuous on the dorsal and ventro-lateral margins.

¹ In the June number of the Proceed. Acad. Nat. Sci. Phila. 1862, p. 147, the subgeneric name *Trematodiscus* was proposed by the writer and Mr. Worthen, for such fossil species as *Nautilus strigalis*, *N. Edwardsianus* and *N. omalianus*, Koninck; and *N. sulcatus*, *N. pinguis*, &c., Sowerby. Since that time we observe Prof. McCoy had proposed, in 1844 (Carb. Foss. Ireland), the name *Temnocheilus* for a group including some of the same forms. As his first species, however (*N. biangulatus*, Sowerby), and several of the others ranged by him under that name, differ considerably in form and surface characters from the types for which the name *Trematodiscus* was proposed, it may be convenient to restrict *Temnocheilus* to such forms as *N. biangulatus*, Sowerby; and *N. pinguis*, and *N. coronatus*, McCoy; and to retain *Trematodiscus* for those agreeing with its type as originally proposed. If it should be thought desirable, however, to group all these forms together, Prof. McCoy's name *Temnocheilus* would have to take precedence, as it was first published.

It is also worthy of note that Blainville had, in 1824 (Dict. Sci. Nat. tom. 32, p. 185) included some similar forms under the name *Simplegas*, adopted from Montfort. It will be remembered, however, that the type of Montfort's genus *Simplegades* (not *Simplegas*), is an *Ammonite* or *Ceratite*; while the first, or typical species of *Simplegas*, Blainville, is a true *Nautilus*.

In 1842, Mr. G. B. Sowerby adopted, in his Manual (p. 276), Blainville's name *Simplegas*, and figures as an illustration of the group *N. sulcatus*, Sowerby, a typical *Trematodiscus*. Although he writes the name *Simplegas*, he cites Montfort as the author of the group, and yet admits that the type of *Simplegades*, Montfort, has sinuous septa like *Ammonites*.

² The name *Pteronutilus* is proposed for a remarkable undescribed Permian genus, of which *Nautilus Seebachianus*, Genitz, is the type (see Dyas, p. 43, tab. 11). It may be characterized as follows:—

GENUS *Pteronutilus*, MEEK.

Shell with the involute body portion comparatively very small and globular in form, scarcely umbilicate. Outer chamber very large, and deflected from the involute body, its inner or ventral side being widely open, and the lateral margins greatly dilated, so as to form a very large wing-like expansion on each side.

Conchologists will readily understand that such a shell as this must have been inhabited by an animal differing widely in its structure from a living typical *Nautili*.

Of the large number of older fossil species referred to the genus *Nautilus*, some undoubtedly belong to distinct genera, while others fall into subgeneric groups, differing more or less from the recent typical forms. If we admit *Discites*, *Trematodiscus*, *Cryptoceras* and several other equally marked forms into this genus, we may regard it as dating back to the Silurian epoch. Species approximating the typical *Nautili*, however, did not exist, so far as known, before the Carboniferous period, and even the few of modern aspect then introduced, present peculiarities in their septa, or in the position of the siphon, that readily distinguish them from the more recent types; while the great majority of their supposed congeners of that epoch are still more aberrant. The same may also be said in regard to the known Permian species.

In the Triassic and Jurassic rocks, along with some of more modern aspect, we meet with a number of species which, from the lobed or sinuous character of their septa, and other peculiarities, seem to form sections or subgenera, and apparently in some instances, distinct genera. The Cretaceous and Tertiary rocks, as might be expected, contain a larger proportion of true *Nautili*, but even in the Tertiary, the older type of structure is repeated in the genus *Aturia*, of Bronn (= *Aganides*, Montfort?), which, with a ventral siphuncle, has deep lateral lobes in the septa, similar to those of *Goniatites*.

Some five or six recent species of *Nautilus* have been described by Conchologists. They are found in the Chinese and Indian Seas, Persian Gulf, &c. As they have rarely been seen alive, little is known in regard to their habits.

***Nautilus eccentricus*.**

(PLATE II, Fig. 14, a, b.)

Nautilus eccentricus, MEEK & HAYDEN, Trans. Albany Inst. IV, 1858.

Shell small, somewhat compressed; volutions apparently not more than one and a half, not embracing, rounded excepting near the aperture, where the non-septate portion presents an oval transverse section. Umbilicus wide, shallow, and showing all of each whorl. Septa moderately concave; siphon small, placed about half way between the centre and the outer, or dorsal side. Aperture transversely oval. (Surface unknown.)

Length, 0.70 inch; height, 0.53 inch; breadth at the aperture, 0.43 inch; small diameter of aperture, 0.25 inch.

We have some doubts in regard to the propriety of retaining this species in the genus *Nautilus*, since it seems to consist of little more than one entire whorl, apparently surrounding an open central space. In this character (if it is not due to some accident), as well as in the eccentric position of the siphuncle, it would seem to present affinities to the genus *Gyroceras*; from which, however, it differs in having the whorls coiled so as to come in contact. Excepting in the rounded or non-sulcate character of the whorls, it appears to approach the group *Trematodiscus*.

Locality and position.—Near the mouth of Smoky Hill fork of Kansas River. Permian. (Type 4185.)

REPTILIAN AGE.

(JURASSIC PERIOD.)

RADIATA.

CLASS ECHINODERMATA.

ORDER Crinoidea.

FAMILY PENTACRINIDÆ.

Genus PENTACRINITES, MILLER.

Synon.—*Pentacrinites* (SCHLOT.), MILLER, Nat. Hist. Crinoid. 1821, 56.—GOLDF. Petref. Germ. I, 1826, 168.—ROEMER, Ool. 1836, 29; Kreid. 1841, 26.—BRON. Leth. Geog. 1836, 219.

Pentacrinus, AGASSIZ, Prodr. Mong. Ech. Mem. Soc. Sci. Nat. Neuchatel, 1835, 195; and various later authors.

Chladocrinus, AG. lb. 196.

Ety.—πεντάς, five; κρίνον, a Lily.

Examp.—*Pentacrinites briareus*, MILLER.

Column more or less distinctly pentagonal, with central cavity small and rounded; provided with lateral branches or accessory arms arranged in verticils; segments ornamented with star-like sculpturing on their upper and lower surfaces. Body small, composed of five small or rudimentary basal plates, and fifteen larger radials, in five series of three each, without inter-radial pieces. Visceral cavity protected by a covering of numerous very small polygonal plates. Arms large, long, frequently bifurcating, and provided with numerous jointed tentacles.

Prof. Agassiz separates this group into two sections, as follows:—

1. *Pentacrinites* (proper).

Column with lateral branches simple.

2. *Chladocrinus*, or *Cladocrinus*.

Lateral branches of column themselves provided with verticillate branchlets.

Probably the most ancient known species of this genus are from the St. Cassian beds of the Tyrol, often referred to the Trias, but by some included in the Jurassic system. The genus attained its greatest development during the deposition of the Jurassic rocks; but occurs in the Cretaceous and Tertiary deposits, and is represented by a few species in our existing seas. It has not been found in this country east of the Black Hills.¹

¹ It is an error, we think, to quote *Pentagonites*, Rafinesque (Jour. de Phys. LXXXVIII, 1819, 429), described by him, with other fossils from some of the Palæozoic rocks of the Western States, as a synonym of *Pentacrinites*. On the contrary, his type was more probably one of the Silurian Crinoids

Pentacrinites asteriscus.(PLATE III, Fig. 2, *a*, *b*, and annexed cut?)*Pentacrinus asteriscus*, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, p. 49; MEEK & HAYDEN, ib. Oct. 1860, 419.Comp. *Pentacrinus scalaris*, GOLDF. Petrefact. Germ. tab. 52, fig. 3; also Quenstedt Der. Jura, tab. 13, figs. 49-57.

Our knowledge of this crinoid is entirely derived from detached segments of its column, and other parts, as seen imbedded in a sandy matrix, cemented by calcareous matter. The joints of the column may be characterized as rather small, thin, very symmetrical pentagonal star-shaped bodies, the rays of which are usually a little longer than wide, and somewhat acutely angular at their extremities. Through the centre of each of these joints, there is a minute circular perforation, from which five lance-oval petaloid areas radiate, one to the extremity of each of the angles; the areas being bounded on each side by rather narrow, slightly elevated crenulate margins.

This description applies more particularly to the largest sized specimens, measuring about 0.18 inch across from point to point of the opposite angles (see Pl. III, fig. 2, *a*, *b*.) Associated with these, there are smaller joints, varying from 0.05, to 0.10 inch in diameter, having proportionally shorter and broader rays, which are usually less angular at the points than those of the larger ones. These may possibly prove to belong to another form, though it is quite as probable they are only joints of smaller individuals of the same species. The annexed cut represents some of these smaller less distinctly angular columns, from a locality on North Platte River.

The specimens are all so very similar to the corresponding parts of *P. scalaris*, Goldfuss, that after more careful comparisons we are inclined to the opinion that they may possibly prove to belong to that species. Still, as they are all much smaller than those figured by Goldfuss and Quenstedt, and none of them have the points of the rays so rounded, we have concluded to retain our name until their difference or identity can be established by a comparison of specimens.*

Locality and position.—Associated with other Jurassic fossils at the southwest base of Black Hills; and opposite Red Buttes, North Platte River. (Type 220.)



Pentacrinites asteriscus?
North Platte River.

for which Prof. Hall subsequently proposed the name *Heterocrinus* (Pal. N. Y. Vol. I); which has a distinctly pentagonal column, and is common in the Blue Limestone of the age of the Hudson River Group, in Ohio, Kentucky, and Indiana, as well as New York. Rafinesque's name, however, cannot be adopted for this Palæozoic group, since he gave no characters by which either the genus or the typical species, could be certainly identified.

MOLLUSCA.

CLASS BRACHIOPODA.

FAMILY LINGULIDÆ. (See page 1.)

Genus LINGULA, BRUGUIÈRE.

Synon.—*Lingula*, BRUG. Encyc. Méth. I, 1792, tab. 250.—CUVIER, Tab. Elem. 1798, . . . ; Ann. Mus. I, 1802, 69.—

LAMK. Prodr. 1799, 89; Syst. Ann. 1801, 140.

Pharetra, BOLTON, Mus. Bolt. 1798, 2d ed. 1819, 111 (not Hübn. 1816).

Etym.—*Lingula*, a little tongue.

Type.—*Lingula anatina*, LAMK.

Shell oblong or more or less oval, depressed, thin, gaping at each end, and rounded or subtruncate in front, and more or less pointed at the beaks—consisting of alternate corneous and testaceous laminæ, the former of which are fibrous and the latter tubular; composition largely phosphatic. Valves both moderately convex, held together by the action of muscles; beak of ventral valve more pointed and prominent than that of the other. Surface smooth, or marked by concentric lines, sometimes crossed by radiating striæ. Peduncle long, thick, cylindrical, fleshy, and flexible.

On the inner side of the shell of the typical forms of this genus, the marks of the visceral sac and the scars of the complex muscular system occupy most of the posterior half of the valves. In the dorsal or shorter valve, this visceral area has a somewhat rhombic or suboval form, and in the ventral valve its outline is ovate-cordate, or more or less flabelliform. The area thus designated is usually thicker in both valves than other parts of the shell, especially in old examples, so as to leave a slight impression on internal casts.

Of the muscular impressions, the form and position of which have been noted, there are twelve in the dorsal, and thirteen in the ventral valve. The scar of the peduncular muscle is situated immediately within the beak of the ventral valve; and just in front of it is the scar left by the divaricator muscles (of Hancock = posterior adductors of Woodward). At the anterior extremity of the visceral area, in the middle of the same valve, are the four very unequal scars of the posterior oclcluser, and external and central adjustor muscles (of Hancock), which are so arranged and impressed as to impart a more or less trilobate outline to the anterior margin of the slightly more convex visceral area. Behind these, and just within each lateral lobe of the visceral area, are situated, one on each side, the widely separated anterior oclcluser scars; and still further back, we see on each side those of the posterior adjustors, of which there are two on one side, and one larger on the other.

In the dorsal valve, there is no peduncular attachment, but the scar of the divaricator muscles is located nearly as in the other valve. The two anterior occlusor impressions of this valve are placed in contact, centrally, side by side, at the farthest anterior extremity of the visceral area; and just behind these, and a little separated from each other, are the two impressions of the posterior occlusor muscles. About midway between the latter and the posterior extremity of the visceral area are situated, near each lateral margin, the small scars of the posterior, external, and central adjustor muscles, of which there are four on one side, and three on the other, one of the latter being considerably larger than the others.

This genus is closely allied to the recently separated *Lingulepis*, and until the muscular impressions of the type of that proposed genus have been more clearly determined, there is some room for doubt whether or not it is really distinct. The principal differences yet observed between these two types, consist in the ovate subtrigonal form, and more attenuate beak in *Lingulepis*; and the much more distinctly trilobate visceral scar of its ventral valve. The visceral scar of its dorsal valve is also more flabelliform than in the typical *Lingula*.

The genus *Lingula* was introduced at a very early period; at any rate, we find species in no way distinguishable from it, at least by any external characters, in some of the oldest of the Silurian rocks. Its remains are likewise found ranging through all subsequent formations, and several species are known to inhabit our existing seas. It seems to have attained its maximum development during the Silurian Age. The living species are found on the coast of California, the Sandwich and Philippine Islands, and on the shores of South and North Carolina, and the West Indian Island of St. Thomas. They inhabit shallow water, being generally found at low tide, with their long peduncle deeply penetrating the sand or mud.

Lingula brevirostris.

(PLATE III, Fig. 3, a, b.)

Lingula brevirostris, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, p. 50; Id. Ib. MEEK & HAYDEN, Oct. 1860, p. 419.

Shell subovate, varying to spatulate-ovate, very thin; lateral margins nearly straight, or somewhat convex, generally converging a little towards the beaks; front subtruncate or abruptly rounded; cardinal extremity narrowly rounded. Beaks obtuse and apparently not extending beyond the cardinal margin. Valves equally convex along the middle, and compressed towards the front and sides. Surface polished, and marked by fine, rather obscure lines of growth; on the surfaces of the inner laminae traces of extremely fine longitudinal striae are sometimes visible by the aid of a magnifier.

Length, 0.57 to 0.58 inch; breadth, 0.33 to 0.35 inch; convexity of the two valves, 0.16 inch.

This shell bears some resemblance to the Oolitic species *L. Beanii*, Phillips, but is generally broader toward the front, and more obtusely rounded at the cardinal extremity.

Locality and position.—Southwest base of the Black Hills, Idaho Territory—lower part of the Jurassic rocks of that region. (Type 206.)

FAMILY RHYNCHONELLIDÆ.

Shell oval, oblong, subtrigonal or globose, fibrous and impunctate; hinge line curved, and without a proper cardinal area; dental laminae varying with the genera; supports of oral appendages short and curved, or rarely developed into spiral calcified coils, which are always arranged vertically; muscular impressions much as in *Terebratula*.

Animal, in the living representatives of the family, attached by a muscular peduncle passing through an aperture under the beak of the larger valve; oral arms fleshy, spiral, flexible, and attached to the small curved processes of the smaller valve, towards the middle of the concavity of which the apices of the coils are directed; mantle not adhering, fringed with a few short setæ.

The shells of the *Rhynchonellidæ* have sometimes much the appearance of some forms of the *Terebratulidæ*, but may be distinguished by the absence of a rounded perforation at the extremity of the beak, by their impunctate structure, and differently formed brachial supports. From the *Spiriferidæ*, some types of which they also resemble in form, they are distinguished by the general absence of calcified spiral appendages, or where they do exist, by the apices of the spires being directed vertically, instead of towards the lateral extremities, &c.

This family includes the genera *Rhynchonella*, *Eatonia*, *Camarophoria*, *Pentamerus*, *Atrypa*, *Stenocisma*,¹ *Cælospira*, and probably *Porambonites* and *Camerella*. The type for which *Leiorhynchus* has been proposed, and possibly a few other imperfectly known Palæozoic genera, may also be found to belong to this family. Only the typical genus is known to have living representatives in our existing seas—the other groups being extinct, and, so far as known, confined to the Palæozoic rocks.

Genus RHYNCHONELLA, FISHER, 1809.

Synon.—*Anomia* (sp.), LINNÆUS, and several early authors.

Rhynchonella, FISCHER DE WALDHEIM, Mem. Soc. Imp. Mosc. II, 1809, . . . —BLAINVILLE, Dict. Sci. Nat. t. XLV, 1827, p. 426.—D'ORBIGNY (part), Compt. Rend. XXV, 1847, 268.—DAVIDSON, Brit. Foss. Brach. Genl. Int. 1854, 93, and of various other authors.

Trigoniella, FISCHER DE WALDHEIM, Mem. Soc. Imp. Mosc. II, 1809 (not DA COSTA, 1778).

Terebratulites (sp.), SCHLOT. Petref. 1820, 250.

Hypothyris, PHILLIPS, Palæozoic Fossils, 1841, 55.—KING, Ann. Mag. Nat. Hist. XVIII, 1846.

Hemithyris (sp.), D'ORBIGNY, Compt. Rend. XXV, 1847, 268.

Hemithyris, BRONN, Jahrb. F. Min. 246.

Acanthothyris, D'ORBIGNY, An. Sci. Nat. XIII, 1850, 223.

Etym.—*ῥύγχος*, a beak.

Examp.—*Terebratula acuta*, SOWERBY.

Shell oval or trigonal-subglobose; with or without a mesial fold and sinus; surface with radiating striæ, costæ or plications—rarely smooth or spinous. Beak of larger valve acute, entire, prominent, and more or less curved; foramen variable

¹ See note on page 16.

in size and form, and placed under the beak, by the incurving of which it is often closed or hidden; partly or entirely surrounded (the inner side being sometimes formed by the umbo of the smaller valve) by a deltidium, which is composed of two pieces, and merely rudimentary, or more or less well developed—sometimes produced in the form of a short tube. Hinge composed of two teeth in the larger valve, and two corresponding sockets in the other; the teeth being supported by dental plates which extend to the bottom of the valve. Apophyses of the smaller valve consisting of two short, flattened, moderately curved, and separate laminae, which curve upwards and are attached to the hinge plate. Impressions of the adductor muscle in the smaller valve, quadruple, well defined, and separated by a short longitudinal mesial ridge; scars of the pedicle muscles occupying the cardinal plates. Shell and pedicle muscles of the larger or perforate valve occupying a saucer-shaped cavity at the base of the dental plates; those of the pedicle muscles narrow, elongate, and placed close to the inner bases of the dental laminae—the remaining and larger portion of the cavity being chiefly occupied by the cardinal muscles, which are separated by a small ridge; above these is the small oval adductor scar.

Animal of *R. psittacea*, according to Mr. Davidson, with visceral mass confined to a small space near the beaks, and separated from the general cavity of the shell by a strong membrane, in the middle of which the mouth is situated. Upper lip plain, and the lower cirrhated. Alimentary canal passing through the deeply notched hinge plates, and terminating behind the point of insertion of the adductor muscle in the centre of the valve. Pallial veins consisting of four principal branches in each lobe, opening into larger sinuses. Margins of mantle fringed with a few short setae.

This genus is of very ancient date, having been represented through the various geological epochs from the Silurian down to the present time. The species were quite abundant during some of the Palæozoic periods, as well as during the deposition of some of the Jurassic and Cretaceous rocks, particularly in Europe. The genus seems to be sparingly represented in the Tertiary deposits, and at present but two or three living species are known. The recent species are never so strongly costated or plicated, nor so short and subtrigonal in form as many of the older extinct ones, which, together with some other differences, have led several authors to think them not strictly congeneric.

Rhynchonella —————.

(PLATE III, Fig. 4.)

Our specimens of this shell are too imperfect to enable us to determine satisfactorily whether or not it is identical with any known form. In a genus like this, including so many species, often very closely allied, not much reliance can be placed upon identifications from a few imperfect specimens. It would be easy to point out

characters in which it resembles some Jurassic species, but it seems, so far as can be seen, to be also quite as nearly like others of various ages, even amongst the Palæozoic forms.

Those we have examined are small, subrhomboidal, moderately convex, and have on the dorsal or smaller valve (we have not seen the other) about fifteen simple, obtusely angular plications, four or five of which are raised near the front, so as to form a moderately prominent, rather flattened mesial fold. The surface is also marked by fine, very obscure lines of growth, which are deflected upwards in crossing the plications, near the front.

Locality and position.—Southwest base of Black Hills (Jurassic), Dakota Territory. (Type 319.)

CLASS LAMELLIBRANCHIATA.

FAMILY OSTREIDÆ.

Shell more or less irregular, inequivalve, slightly inequilateral, lying upon, and generally attached by, the left valve. Beaks straight or curved; hinge edentulous; ligament subinternal; muscular impression nearly central, or behind the centre; pallial line obscure, simple.

Animal with its mantle entirely open, and provided with double, fringed edges, which are without distinct ocelli; foot obsolete; gills crescent-shaped, and separated from the palpi; labial appendages triangular, connected around the mouth by a plain membrane.

This family probably only embraces the three closely allied groups—*Ostrea*, *Gryphæa*, and *Exogyra*; the latter two of which are entirely extinct, excepting a single species apparently of *Gryphæa*. The curious extinct genus *Eligmus*, of Deslongchamps, is also placed here by some authors, but we are not well enough acquainted with these peculiar shells to express an opinion in regard to their affinities.

Genus OSTREA, LINNÆUS.

Synon.—*Ostracites*, *Ostreites*, *Limnostracites*, *Ostreum*, &c. (sp.), LLEWYD, KLEIN, and other pre-Linnæan authors.

Ostrea, LINNÆUS, Syst. Nat. ed. 10th, 1758, 696.—O. F. MÜLLER, Prodr. Zool. Dan. xxxi.—BRUG. Encyc.

Méth. I, xiii.—LAMK. Syst. 1801, 132, &c.

Peloris, POLI, Test. Utr. Sic. 1791, 33.

Peloriderma, POLI, ib. II, 255.

Lopha, BOLTEN, Mus. Col. 1798 (2d ed. 117).

Alectryonia, FISCHER DE WALDHEIM, Mus. Dem. 1807, and Bull. Mosc. VIII, 1835.—CHENU, Man. Conch. II, 1862, 167.

Dendrostrea, SWAINSON, Malacol. 1840, p. 389.—G. B. SOWERBY, Conch. Man. 2d ed. 137.

Etym.—ὀστρεον, an Oyster.

Type.—*Ostrea edulis*, LINN.

Shell irregular, subnacreous, laminated, attached by the left or under valve; surface often ornamented by radiating plications, and more or less imbricating, or distinct marks of growth. Upper valve flat or concave; lower valve convex, and having a prominent beak. Ligament occupying a pit or groove in the cardinal area of each valve. Muscular impression subcentral.

Several authors include as subgenera under this group, *Gryphæa*, Lamarek, and *Exogyra*, Say; and it cannot be denied that we are sometimes at a loss to determine to which of these genera a given species should be referred. Indeed, in some cases, we find different individuals of the same species presenting various gradations between the true Oysters and Gryphæas. Whether founded in nature or not, however, these groups are convenient, and can generally be distinguished without difficulty.

The genus *Ostrea* appears to date back as far as the Carboniferous epoch; at any rate, Prof. Koninck has described one species (*O. nobilissima*) from rocks of that age in Belgium. Murchison, Verneuil & Keyserling have also referred to this genus another species (*O. matercula*) from the Permian rocks of Russia. As these, however, are, so far as our knowledge extends, the only evidences we have of the existence of this genus previous to the beginning of the Triassic period, it would seem to have been very sparingly represented, even during the deposition of the latest of the Palæozoic rocks.

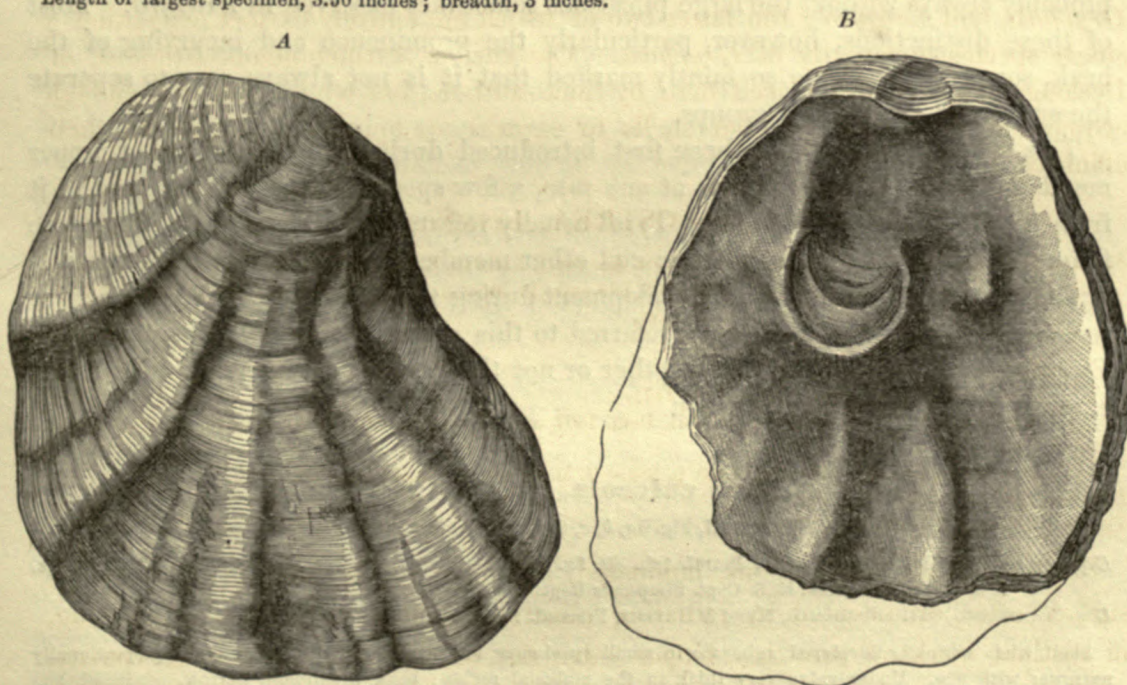
Oysters are not uncommon in the Triassic deposits, and the number of species increases as we ascend through the later formations. The genus is also well represented, as every one knows, and probably attains its greatest development in the bays, estuaries, &c. of the present epoch.

Ostrea Engelmanni.

Ostrea Engelmanni, MEEK, Proceed. Acad. Nat. Sci. Phila. July, 1860, 311.

This species is only known from imperfect detached valves, all of which are much compressed, thin, and present a more or less irregular subovate outline. The beak is truncated, and provided with a broad but short area. The surface is ornamented by from seven to about fifteen irregular, moderately distinct, rather rounded, radiating plications, not usually extending more than about half way from the free margins towards the umbo. Lines of growth regular, rather faint, and not imbricating. Internal margins not crenate near the hinge. Muscular scar rather large, oval, and well defined.

Length of largest specimen, 3.50 inches; breadth, 3 inches.



A. Outside under? valve.

Ostrea Engelmanni.

B. Inside of another specimen.

This species bears some general resemblance to *O. Marshii*, of Sowerby, but is a thinner and more compressed shell, with less prominent, and much less angular plications or costæ. Its area is also proportionally much shorter.

Locality and position.—Jurassic beds at Red Buttes, on the north branch of Platte River, Dakota Territory, lat. 42° 50', long. 106° 40' west. Collected by the Expedition under the command of Capt. J. H. Simpson, of U. S. Top. Engineers. (No. 1884.)

Genus GRYPHÆA, LAMARCK.

Synon.—*Auricularia*, *Auriculites*, &c. (sp.), of LLEWYD and other early writers.

Gryphæa, LAMARCK, Syst. An. 1801, 398.—ROISSY, Mol. 1835, 202.—BLAINV. Dic. Sci. Nat. t. 19, 1821, p. 533.—Risso, Hist. IV, 1826, 290.

Griphæa, BLAINV. Malacol. 1825, 522.

Pycnodonta, FISCHER DE WALDHEIM, Bull. Mosc. VIII, 1835.

Ety.—γρῦψ, a Griffin.

Examp.—*Gryphæa arcuata*, LAMK.

Shell generally free, especially in the adult state. Lower valve deep; beak prominent and distinctly incurved, and but slightly oblique. Upper valve flat or concave; beak usually truncated. Hinge, ligament, and muscular and pallial impressions as in *Ostrea*. (Animal unknown.)

The shells of this genus differ from those of the true Oysters in being more regular, in having the lower valve deeper, and particularly with its beak more prominent and incurved. They seem also to be scarcely ever plicated as we often see in the genus *Ostrea*. From *Exogyra* they differ mainly in having the beak of the lower valve curved upwards and inwards, instead of to one side, as well as being probably always without the large plications sometimes observed in *Exogyra*. Most of these distinctions, however, particularly the prominence and incurving of the beak, sometimes become so faintly marked that it is not always easy to separate the species of these three groups.

This type appears to have been first introduced during the deposition of upper members of the Triassic series; at any rate, a few species have been referred to it from the St. Cassian beds of the Tyrol usually referred to that epoch. It is more frequently met with in the Liassic and other members of the Jurassic system, and probably attained its maximum development during the deposition of the Cretaceous rocks. A few species have been referred to this genus from the Tertiary rocks of Europe; though it is doubtful whether or not they are true Gryphæas. No living examples of the group are known.

Gryphæa calceola, var. *nebrascensis*.

(PLATE III, Fig. 1a, b, c, d, e, and annexed cuts.)

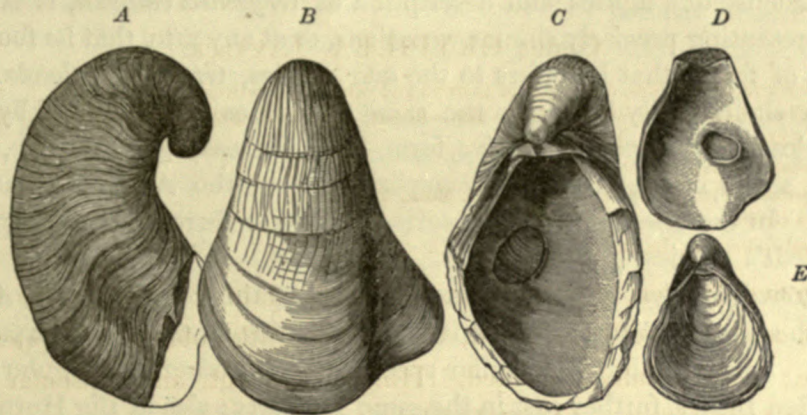
Gryphæa calceola, QUENSTEDT, Handb. Petref. tab. 40, fig. 29–31.—QUENSTEDT, Der Jura, 1856, 352, tab. 48, figs. 2, 3, 4, and 5.—MEEK, MSS. Capt. Simpson's Rept. Utah.

Gryphæa calceola, var. *nebrascensis*, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1861, 437.

Shell, when normally developed, subovate in small specimens, but becoming more elongate and proportionally narrower with age. Under valve very thick in the umbonal region; beak prominent, narrow, produced, and strongly incurved; anterior side with a more or less defined sulcus, which never extends quite to the point of the

beak; area triangular, arcuate, extending close up under the curve of the beak, and provided with a distinct cartilage depression; muscular scar small, shallow, oval, and located near the anterior side; surface ornamented on the gibbous back of the umbo by distinct, irregular, radiating striae, usually extending to near the middle on mature specimens, while the space between this and the ventral margin has only moderately distinct concentric striae and marks of growth. Upper valve ovate, nearly flat on the outside, or a little convex near the beaks, and more or less concave near the middle, usually concave on the inner side towards the cardinal extremity, which is thick and truncated; surface with rather distinct concentric marks of growth.

Length, from the most prominent part of the umbo to the ventral extremity, 2.70 inches; breadth near the ventral extremity, about 1.20 inch; convexity, 0.73 inch. (Type No. 1881.)



Gryphaea calceola, var. *nebrascensis*.

A. Side view lower valve. B. Under side same. C. Inside same. D. Inside view of an upper valve.
E. Upper view of a small specimen with the two valves united.

The normal form of this shell, as may be seen by the above cuts, agrees so very nearly with Quenstedt's *G. calceola*, that we cannot but regard it as most probably only a variety of that species. It has the same narrow, elongated, arcuate form, radiately striated umbo, and general appearance of the fully developed specimen of *G. calceola*, represented by Quenstedt's fig. 1, pl. 48, above cited, excepting that the beak of the under valve seems never to be quite so arched over and produced; while the sulcus along its anterior side of the exterior is not continued so nearly to the point of the beak.

Along with the form above described, we have from the same and other localities a few specimens with the point of the beak slightly truncated by a small scar of attachment, much as we see in fig. 4, pl. 48, of Quenstedt, referred by him provisionally to *Ostrea calceola*, Goldf.

At some localities nearly all the specimens have the beak truncated, and many of them seem to have been attached by so large a surface as to have entirely obliterated the umbo of the under valve, thus giving them all the characters of a true Oyster. Fig. 1a, b and d, Pl. III, represent some of these specimens, one of which, fig. 1d, will be seen to present very nearly the form and general appearance of fig. 2, pl. 48, Quenstedt, the most extremely abnormal type of the series. Between these extremes we find every intermediate gradation, so that it seems to be impossible to base specific distinctions upon these differences. We are, therefore, inclined to regard these shells as all belonging to one variable species, the differences being probably caused by the more or less favorable conditions of different

localities or particular positions. Where the conditions were favorable, the shells attained a larger size, grew more symmetrically, and present the normal form of a true *Gryphæa*; but where exposed to the action of waves or too strong currents, they were probably more firmly attached, are smaller, more irregular in form, and have the umbo sometimes partly, sometimes entirely obliterated by the large scar of adhesion, which in a few extreme cases occupies the whole lower surface of the under valve.

From Quenstedt's figures and description of *Gryphæa calceola*, it is evident he found it presenting precisely similar variations, or at any rate, that he found a similar gradation of forms that he refers to the one species, *Gryphæa calceola*. Whether or not our shells really belong to the same species as those figured by Quenstedt, or to a closely allied representative form, it is not easy to determine, without an extensive series of specimens for comparison from the American and European localities. In the absence of such a series we have referred our shells provisionally to Quenstedt's species.

Locality and position.—The forms represented by the foregoing cuts, *A, B, C, D, E*, are from the Jurassic beds of Wind River Mountains, in the southern part of Dakota Territory. Some smaller, but similar specimens with other less regular forms, were found in Red Buttes, further east in the same Territory; also at Big Horn Mountains. The specimens figured on Pl. III, are from the same position at the southwestern base of the Black Hills, Dakota Territory.

FAMILY PECTINIDÆ. (See page 48.)

SUBFAMILY PECTININÆ. (See page 48.)

Genus CAMPTONECTES, AGASSIZ.

Synon.—*Pecten* (sp.), SOWERBY, Min. Conch. III, 1818, 3.—ROEMER, Die Vert. des Nord. Kreid. p. 50.—D'OREIGNY, Pal. Franco. III, p. 592, and of various others (not MÜLLER).

Camptonectes, AGASSIZ, MSS.—MEEK, Smithsonian Catalogue Jurassic Fossils of North America.

Etym.—καμπτος, curved; νηπιος, a swimmer.

Examp—*Pecten lens*, SOWERBY.

Shell thin, subequivalve, lenticular, closed; hinge generally short, straight, edentulous; ears compressed, anterior one of the right valve separated from the margin below by a well defined, often deep, byssal sinus. Surface ornamented with radiating, impressed striæ, which curve strongly outwards in approaching the lateral margins, and often present a punctate appearance produced by the crossing of regular concentric striæ. Muscular impressions faint, apparently as in *Pecten*. (Animal unknown.)

Prof. Agassiz proposes this genus for the reception of such species as *Pecten lens*, and *P. obscurus*, Sowerby; *P. striato-punctatus*, Roemer, *P. virgatus*, Neilson, &c. It will probably be also found to include several nearly smooth or concentrically striated Jurassic and Cretaceous forms, since we find faint traces of curved, radiating

or divaricating striæ on *P. cottaldinus*, of Sowerby, which to the unassisted eye seems to be only marked with concentric lines. It is likewise even possible, we think, that this genus may be found to include some Cretaceous species with straight, rigid, radiating costæ, such as *P. galliennei* and *P. rotomagensis*, D'Orbigny, for on both of these shells, which are ornamented with straight, radiating costæ, we observe an entirely distinct system of curved, radiating, or divaricating striæ, which on the lateral margins cross the costæ obliquely; while these shells have the form and deep byssal sinus of the typical *Camptonectes*. Still, they may present some differences in the nature of the hinge or interior that, along with their surface markings, would place them in a distinct genus.

The typical species of this genus will be at once known from all the other groups of *Pectinidæ*, by their peculiar ornamentation alone. That these and various other fossil and recent types usually referred to the genus *Pecten*, should be placed in different genera from that group, as typified by the recent *P. Jacobius*, *P. maximus*, &c., as maintained by Prof. Agassiz, cannot be reasonably doubted.

This genus was introduced during the Jurassic epoch, and ranges through several members of the Cretaceous system, the deposition of which it seems not to have survived.

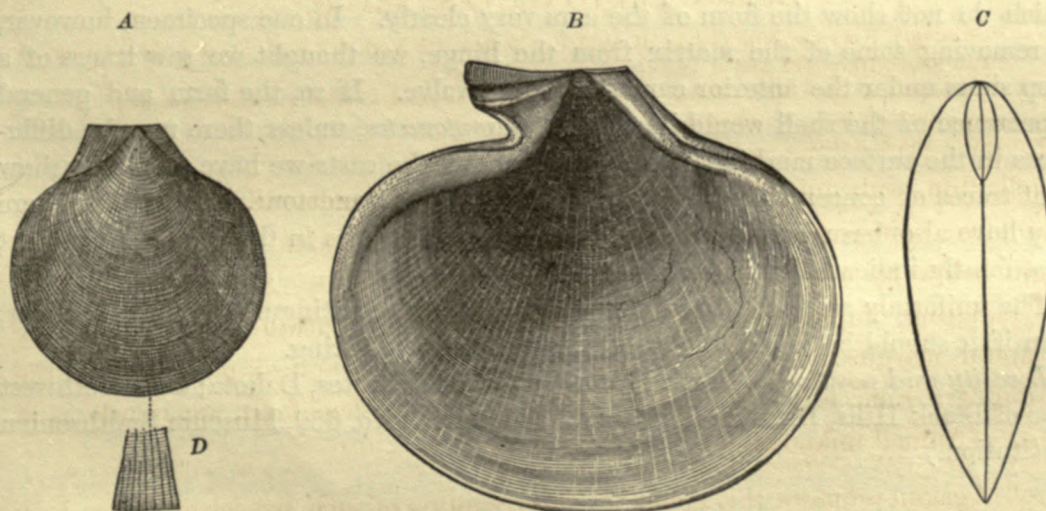
***Camptonectes bellistriatus*.**

Pecten bellistriatus, MEEK, Proceed. Acad. Nat. Sci. Phila. July, 1860, 311.

Camptonectes bellistriatus, MEEK, Smithsonian Cat. N. Am. Jurassic Fossils, 1864.

Shell very thin, compressed-lenticular, suborbicular; valves nearly equally convex; hinge line equalling two-fifths to one-half the transverse diameter of the valves; posterior ear very short or nearly obsolete, flat, and obliquely truncated; anterior ear larger, flattened, and marked by rather distinct lines of growth—in the right valve separated from the adjacent margin by a more or less angular sinus one-third to one-half as deep as the length of the ear, measuring from the beak. Surface striæ very fine, regular, sharply impressed, and increasing in number by the intercalation of others between as they diverge in extending from the umbonal region—so strongly arched as to run out on the hinge line near the beaks; concentric striæ fine, regular, closely arranged, and often nearly or quite obsolete on the flattened spaces between the impressed radiating striæ, to which latter they impart a sub-punctate appearance.

Length of a large shell, 2.65 inches; breadth from hinge to ventral margin, 2.26 inches; convexity, 0.64 inch.



Camptonectes bellistriatus.

A. Outside view of a small left valve. D. Enlargement of surface striæ of same. B. Inside view of a large right valve [the appearance of radiating markings within is an error in the engraving]. C. Outline of right and left valves united.

This species seems to be nearly related to *Pecten lens*, of Sowerby; but as no good figures or descriptions of the right valve of that species, from the original locality, have yet been published, and several distinct species have probably been confounded under that name, we are somewhat at a loss how to point out the distinctive characters of our shell. Sowerby's figures and description, especially, give us no very satisfactory characters for identification or comparison, and that given by Morris & Lyeett (Monogr. Grt. Oolite, tab. ii, fig. 1) is also apparently of a left valve only, though from a better specimen than those figured by Sowerby. Compared with this, our shell is proportionally broader, and has a shorter hinge line, as well as shorter ears. From the species figured by Goldfuss, under Sowerby's name (Petref. Germ. ii, tab. xci, fig. 3), it will be readily distinguished, by its smaller posterior ear, and much deeper byssal sinus; this latter character will also distinguish it from the forms figured as *Pecten lens*, by Bronn (Leth. tab. xix, fig. 7).

The species figured by D'Orbigny (Geol. Russ. II, tab. xlii, 1) as *P. lens*, resembles that before us very nearly in form, the depth of its byssal sinus, and most of its other characters, but our species may be at once distinguished by its shorter obliquely truncate posterior ear. As near as can be determined from D'Orbigny's figures, the form described by him seems to be more coarsely striated.

Locality and position.—Red Buttes, and below there on the north branch of Platte River, Dakota Territory. Jurassic. (Type No. 680, Smithsonian Museum.)

Camptonectes? extenuatus.

(PLATE iii, Fig. 6.)

Pecten extenuatus, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, p. 184.

Shell small, broad-ovate, or subcircular, compressed, lenticular; ventral margin regularly rounded; hinge line short (ears unknown). Surface of casts apparently only marked with concentric striæ.

Antero-posterior diameter, 0.90 inch; breadth from hinge to ventral margin, 0.98 inch; convexity, about 0.28 inch.

This species is rather abundant, but all the specimens we have seen are casts, which do not show the form of the ears very clearly. In one specimen, however, in removing some of the matrix from the hinge, we thought we saw traces of a deep sinus under the anterior ear of the right valve. If so, the form and general appearance of the shell would be that of *Camptonectes*, unless there may be differences in the surface markings. As stated above, the casts we have seen only show faint traces of concentric striæ; but as they are in sandstone, it is possible there may have also been fine curved radiating striæ, if not as in the typical species, at least faintly indicated as in *Pecten cottaldinus*, D'Orbigny.

The uniformly smaller size of this shell will alone distinguish it from the last, even if it should be found to agree in its surface sculpturing.

Locality and position.—North Platte below Red Buttes, Dakota; and southwest base of Black Hills, Dakota Territory. Jurassic. (No. 680, Museum Smithsonian Institution.)

FAMILY PTERIIDÆ. (See page 27.)

SUBFAMILY PTERIINÆ. (See page 28.)

GENUS PTERIA, SCOPOLI.

Synon.—*Pteria*, SCOPOLI, Introd. Hist. Nat. 1777.—GRAY, Zool. Proceed. 1847, 199.—MEEK, Am. Jour. Sci. and Arts [2], XXXVII, 1864, 217.

Avicula (KLEIN), BRUG (part), Encyc. Méth. 1792, pl. 177.—CUVIER (part), Tab. Elem. 1798; Anat. Comp. 1800; Règne An. 1817.—LAMK. Prodr. 1799; Syst. An. 1801, 134; Phil. Zool. 1809, 318, &c.

Margaritifera (sp.), HUMPH. Mus. Col. 1797, 44.

Pinctada, LINK, Besch. Rost. 1807 (not BOLTON, 1798).

Unionium, LINK, ib.

Anonica, OKEN, Handb. d. Zool. 1815; Natgesch. f. Schulen. 1815, 652.

Perlamater (sp.), SCHUM. Ess. 1817, 107.

Ety.—πτερόν, a wing.

Examp.—*Mytilus hirundo*, LINN.

Shell obliquely subovate, or subtrigonal, fragile; surface smooth, striated, costated or subspinous—often with imbricating marks of growth; inequality of valves generally distinctly marked; byssal sinus in the anterior margin of the right valve well defined. Cardinal margin long, straight, and produced into more or less distinct wings at the extremities—the posterior wing being larger than the other. Hinge with usually one or two small cardinal teeth under the beak of each valve. The (simple) pallial line represented by a row of minute irregular scars, extending from the subcentral impression of the adductor muscle obliquely forward to the small anterior muscular scar beneath the beaks.

Amongst the numerous fossil species referred by various authors to this genus, there are, in addition to the several types we believe to belong to clearly distinct genera, others which differ sufficiently from the living typical species to constitute at least well marked sections. It is not our purpose, nor have we the necessary material at hand, to attempt to define here all of these various subordinate groups, though it becomes necessary to notice one of those including a species with which we have to deal. The section to which we allude may be designated as follows:—

Oxytoma, MEEK.

Shell differing from the typical forms of *Pteria* (= *Avicula*), in being less oblique, proportionally shorter, more distinctly inequivalve, and usually more strongly costate—particularly on the left valve, around the pallial margins of which the costæ are sometimes produced in the form of free spines. The byssal sinus of the right valve is also much deeper and more sharply defined than in the typical species of *Pteria*.

Type *Avicula Munsteri*, GOLDF. Petref. Germ. II, pl. cxxviii, 2 a, to h.¹ Also includes *A. costata*, MORRIS & LYCETT, *A. digitata*, and apparently *Monotis interlavigata*, QUENSTEDT, and *A. cygnipes*, PHILLIPS.

This section forms a transition from the typical *Avicula* to the genus *Eumicrotis*, and seems to be mainly, if not entirely, confined to the Jurassic rocks.

The genus *Pteria*, or *Avicula*, is so nearly related to the older extinct genus *Pterinia*, that the two groups are generally confounded, where the hinge and in-

¹ Several species appear to have been confounded under the name *A. Munsteri*, by other authors. We regard the particular form figured by Goldfuss as the type of the section *Oxytoma*.

terior cannot be seen. They can be readily distinguished, however, when we have an opportunity to examine the hinge, which in *Pterinia* differs from that of *Pteria*, in the possession of a more or less broad cardinal facet, marked with linear cartilage furrows, but without a cartilage pit; as well as in having oblique posterior and anterior teeth not found in the true *Pterias*. From *Meleagrina* and *Mallæus*, which some authors include in this genus, the *Pterias* can be readily distinguished by obvious differences of form.

It will be very difficult to determine at what particular period this genus, as properly restricted, was first introduced, until the nature of the hinge of many extinct species can be determined. Palæontologists, who are often too much inclined to lose sight entirely of the existing types upon which so many genera of Mollusks were originally founded, refer to it many species from the Palæozoic rocks; but many of these older species are known to be true *Pterinias*; and it is more than probable, as already stated in the remarks on this family, that the Silurian, Devonian, and many, if not all, of the Carboniferous and *Permian* species referred to *Avicula*, will be found to belong to *Pterinia*, *Bakevellia*, &c., or to undescribed genera. Our present impression is, that typical species of *Pteria* did not exist previous to the Cretaceous epoch, and that probably none of the forms from rocks older than the Jurassic, or possibly from the Trias, can be properly included, even as distinct subgenera. The genus is represented in the Cretaceous and Tertiary deposits, but seems not to have been more extensively developed at any past time than at present in our existing seas. The living species are found on the coast of South America, of the British Islands, and in the Mediterranean and Red Seas, the Indian Ocean, &c.

Subgenus OXYTOMA.

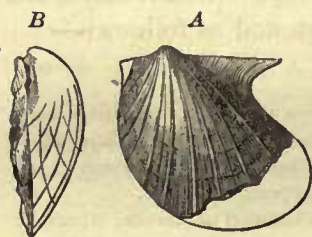
Pteria Munsteri.

Avicula Munsteri, BRONN, Leoh. Zeitsch. 1829, 76.

Avicula Munsteri, GOLDF. Petref. Germ. II, 131, cxviii, a, b, c, d, e, f, g, h.

Monotis Munsteri, QUENSTEDT, Württ. 341; Ib. Der Jura, II, 1856, 440, lx, 6.

Shell obliquely oval; hinge line less than the greatest parallel diameter of the valves, and ranging at an angle



Pteria Munsteri.

A. Outside view of left valve.

B. Profile of same.

a few small marks of growth, and (probably on well preserved specimens) concentric striae.

Diameter at right angles to the hinge, about 0.93 inch; do. parallel to the same, about 1 inch; convexity of left valve, near 0.24 inch.

We have referred this shell (provisionally) to *Avicula Munsteri*, of Bronn, rather because the imperfect specimens we have yet seen do not exhibit any reliable

characters by which it can be distinguished, than from being satisfied that it is really identical. The few specimens in the collection consist of imperfect left valves, none of which give any idea of the form of the anterior wing; while their finer surface markings are nearly obliterated by exfoliation and weathering. It is more than probable that perfect specimens showing the nature of the surface markings of both valves will be found to present characters by which this shell may be distinguished from *Avicula Munsteri*; if so, it may take the name *Pteria mucronata*, or *Avicula mucronata*, if the latter generic name is retained.

Locality and position.—Wind River Valley, Dakota Territory. Jurassic. (Type 1893.)

Genus EUMICROTIS, MEEK. (Page 53.)

Eumicrotis curta.

(PLATE III, Fig. 10, a, b, c, d.)

Avicula curta, HALL, 1852, Capt. Stansbury's Rept. Ort. Salt Lake Exp. 412, pl. 2, fig. 1, a, b.

Avicula (Monotis) tenuicostata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 50.

Monotis curta, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Oct. 1860, 418.

Eumicrotis curta, MEEK, Smithsonian Check List N. Am. Jurassic Invert. Fossils, 1864.

Shell suborbicular, very slightly oblique, usually a little higher than long, moderately convex, and nearly equi-valve; anterior side more or less rounded; ventral and postero-ventral margins rounded. Posterior border ascending obliquely forward, and sometimes slightly concave in outline above. Hinge margin straight, and considerably shorter than the length of the shell, compressed behind, so as to form a very short, more or less angular wing, which is sometimes nearly obsolete; rounding or very obtusely angular in front of the beaks, but not terminating in a wing. Beak of left valve small, and rising a little above the hinge; that of the other valve more compressed, and scarcely distinct from the cardinal margin—both located slightly in advance of the middle. Byssal sinus small, rather deep, angular, and connected with a narrow external groove extending nearly parallel with the hinge margin to the beak. Surface of left valve ornamented by radiating lines; that of the right valve generally only marked with concentric striæ.

Length, 0.60 inch; height, 0.64 inch; breadth or convexity, 0.26 inch.

The radiating lines of the left valve are regular, and usually rather smaller than the depression between; they seem to be always simple, though many of them die out before reaching the beaks. On the right, or smaller valve, they are always very obscure, and often obsolete, while the concentric striæ, in most cases, are moderately distinct. In adult shells, the hinge line is often proportionally shorter than in smaller individuals.

This species varies in form, some of the specimens being longer, and some shorter than wide. Those figured by Prof. Hall are in a bad state of preservation, and give an imperfect idea of the characters of the species; though we are satisfied, from direct comparison with other specimens obtained at the same locality, as well as with those collected by Capt. Stansbury, that our shell belongs to this species.

In form, surface markings, and indeed in almost all its characters, this shell agrees so very closely with *Monotis substriata*, Munster, that we are strongly inclined to the opinion that it will, on comparison, prove to be identical. It is generally a little less oblique than the figures of that shell given by Goldfuss, Quenstedt, and others, but varies in this respect. Were it not that some authors describe *M. substriata* as being plano-convex, while the two valves of our shell are nearly equally convex; and that none of the descriptions we have read mention any difference in the distinctness of the radiating striæ on the two valves, we would scarcely hesitate to refer the specimens now before us to *M. substriata*.

Locality and position.—Southwest base Black Hills. Jurassic. (Type No. 205.)

FAMILY TRIGONIIDÆ. (See page 57.)

Genus TRIGONIA, BRUGUIÈRE.

Synon.—*Trigonia*, BRUG. Encyc. Méth. I, 1789, xiv, pl. 237.—LAMK. Prodr. 1799, 86; Id. Syst. An. 1801, 116, and An. du Mus. IV, 1804, p. 351.—ROISSY, Mol. VI, 1805, 392, &c.

Lyrodon, G. B. SOWERBY, Genera Shells, 1833, fasc. 41.

Lirodon, BRONN, Leth. 1837 (sec. ed.) 367 and 700.

Lyriodon (part), GOLDF. Petref. Germ. II, 1837, 196.—BRONN, Jahrb. 1838, p. 108.

Etym.—τρίγωνος, three cornered.

Type.—*Trigonia scabra*, LAMK.

Shell subtrigonal, longitudinally ovate, elongate, or subcircular; postero-dorsal region often provided with a more or less distinctly defined escutcheon or corselet. Surface ornamented with radiating, oblique, or concentric costæ or rows of nodes; rarely smooth. Beaks usually elevated. Ligament short and prominent. Hinge thick, composed of two large diverging, elongate, transversely furrowed teeth, in the right valve, and three or four in the left, furrowed only on one side. Impressions of adductor muscles usually well defined, the anterior being located near the beaks. Scar of posterior pedal muscle located a little above, and in front of, the impression of the posterior adductor; antero-pedal scar generally placed within the cavity of the beaks, sometimes wanting in the right valve.

Many of the extinct species generally referred to this genus differ so widely in form and surface ornamentation from each other, as well as from the living *Trigonias*, as to leave room for doubts whether or not they really all belong to one and the same genus. These differences attracted the attention of Prof. Agassiz, who separated the several types into distinct sections, which he accurately describes in his excellent monograph of the genus. These sections may be briefly characterized as follows:—

1. "Les Scaphoides," AGASSIZ.

Shell subtrigonal, longer than high; anterior side short and truncated; posterior side long and very abruptly rounded or subangular at the extremity. Dorsal corselet large and nearly smooth, excepting the lines of growth; not defined by a ridge or sulcus on either side. Surface ornamented with varices in front, and more or less nodose, transverse or oblique costæ on the flanks.

Type.—*Trigonia navis*, LAMK. (*Jurassic and Cretaceous.*)

2. "Les Clavellees," AGASSIZ.

Shell more rounded in front than in the last group; corselet well developed and often bounded by a ridge on either side, sometimes with strong marks of growth. Surface ornamented with more or less nodose costæ, which pass from the margins of the corselet obliquely downwards and forwards, often becoming broken up into a series of isolated tubercles on the sides and front of the valves.

Example.—*T. clavellata*, SOWERBY. (*Mainly Jurassic.*)

3. "Les Carrees," AGASSIZ.

Shell shorter and more truncated at each extremity than the last; also with less regular costæ on the flanks, and a larger and more compressed corselet. Marks of growth often distinct on the corselet.

Example.—*T. quadrata*, AG. (*Upper Jurassic and Cretaceous.*)

4. "Les Scabres," AGASSIZ.

Shell rounded and gibbous in front, elongate, narrowed and subrostrate behind. Corselet separated from the flanks by a more or less distinct groove; ornamented with transverse costæ. Flanks and front with tuberculose, or subspinous costæ, which pass from the margins of the corselet to the base and front, those on the anterior part of the valves curving forward.

Example.—*T. aliformis*, SOWERBY. (*Mainly Cretaceous.*)

5. "Les Ondulees," AGASSIZ.

Shell intermediate in its ornamentation between the last and the next following groups; corselet much as in "*Scaphoides*;" sides and front with longitudinal, generally smooth costæ, abruptly curved upwards behind.

Example.—*T. undulata*, FROMM. (Jurassic and Cretaceous.)

6. "Les Costees," AGASSIZ.

Shell ornamented on the flanks and front with prominent, generally smooth longitudinal costæ, with scarcely visible marks of growth between. Corselet very distinct, and separated from the flanks by a well defined ridge, formed usually of flattened imbricating prominences; ornamented with numerous small tubercles, or tuberculate costæ, and two radiating crenulated ridges.

Type.—*T. costata*, LAMK. (Jurassic and Cretaceous.)

7. "Les Lissees," AGASSIZ.

Shell depressed, elongate, and rounded at both extremities, smooth, or rarely with obscure traces of concentric costæ in front; lines of growth not strongly marked.

Example.—*T. longa*, AG. (Jurassic and Cretaceous.)

8. "Les Pectinacees," AGASSIZ.

Shell short, oval subtrigonal; without a distinct corselet; surface ornamented with concentric radiating costæ.

Type.—*T. pectinata*, LAMK. (Existing seas.)

These groups, it will be observed, are founded upon differences of form and ornamentation analogous to those presented in the *Unionidæ*, where they appear to be coincident with differences of structure in the animal, considered by Prof. Agassiz of generic value. It does not, however, necessarily follow from this, even if we admit all the proposed genera of *Unionidæ*, that the sections of *Trigonia* under consideration must be viewed as distinct genera; since the differences of form and structure observed in the various groups, and subordinate divisions of the animal kingdom, are so infinite and varied, that we cannot always apply precisely the same rules for the distinction of genera in one family, that serve to distinguish those of another.

The genus *Trigonia* is closely related to *Myophoria*, of Bronn, by which it seems to have been represented, during the Triassic epoch, as the latter was represented during the deposition of the Permian and older rocks, by the genus *Schizodus*, of King. For remarks on the relations of these three groups, see pages 57 and 58.

If we exclude *Myophoria* from the genus *Trigonia*, it will probably be found to range back no farther than about the commencement of the Jurassic epoch, towards the middle of which it seems to have nearly or quite attained its maximum development.¹ It was also well represented during the deposition of the Cretaceous rocks, but appears to have become almost extinct at the close of that epoch, since only a few doubtful instances of its occurrence in Tertiary deposits have been recorded. Some five or six species, however, are known to be still living in the Australian seas.

Trigonia Conradi.

(PLATE iii, Fig. 11.)

Trigonia Conradi, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 183.

Trigonia Conradi, MEEK & HAYDEN, " " " " " Oct. 1860, 418.

Shell rather small, short, subtrigonal, moderately compressed; anterior side truncate; base rounded; posterior side sloping obliquely from the beaks above, and apparently vertically truncate at the immediate extremity. Beaks elevated, narrow, incurved, and located in advance of the middle; posterior umbonal slopes rather distinctly

¹ A few of the Saint Cassian (Triassic?) species may possibly belong to some section of the genus *Trigonia*.

angular. Surface ornamented by small, simple, obscure concentric costæ, which on the posterior side of the valves descend at first perpendicularly, after which they are deflected forward parallel to the basal and anterior borders.

Length and height, each about 0.97 inch; convexity, 0.58 inch.

The specimens of this species we have seen, are not in a condition to have retained fine surface markings if there were any; nor do they show very satisfactorily the character of the corselet, though it seems to have been marked by obscure radiating costæ, and is bounded on each side by the distinctly angular umbonal slopes. The specific name was given in honor of Mr. T. A. Conrad, the well-known Palæontologist of Philadelphia.

Locality and position.—Southwest base of the Black Hills; in the lower Jurassic beds of that region. (Type No. 212.)

FAMILY MYTILIDÆ.

Shell inequivalve, inequilateral, closed, elongate, oval or oblong; covered with a thick dark epidermis; interior more or less pearly; ligament internal or submarginal, very long; hinge nearly or quite edentulous, or sometimes erenate. Posterior muscular impression large, and faintly marked; anterior generally small. Pallial line simple.

Animal with mantle margins free, or united behind so as to form a more or less complete anal tube; labial palpi elongated, pointed, and free; gills two on each side, elongated, nearly equal, united to each other behind, and to the mantle. Foot cylindrical, grooved, and byssiferous.

This group includes the following genera, viz.: *Mytilus*, *Volsella*, *Pachymya*, *Lithophagus*, *Myrina*, *Adula*, *Crenella*, *Hippagus*,¹ and *Stalagmium*.²

Messrs. H. and A. Adams divide it into the following subfamilies, viz.:—

1. *Mytilinæ*. Hinder part of mantle but slightly produced; anterior muscular scar generally small. Including *Mytilus*, and *Myrina*.
2. *Crenellinæ*. Hinder part of mantle produced so as to form false siphons. Includes *Crenella*, *Volsella*, and *Adula*.
3. *Lithophaginæ*. Hinder part of mantle more or less produced; anterior adductor muscle moderate. Includes *Lithophagus*.

The fossil genera *Pachymya*, *Modiolopsis*, and a part of species referred to *Ortho-nota*, seem to belong to this family; but as we know them only as extinct species, it is scarcely possible to determine to what particular section of the group they most properly belong.

¹ Chenu (in Man. de Conch. II, p. 169) places *Hippagus*, Lea, in the family *Trigoniidæ*, and figures Wood's sp. *verticodius*, as a retaceous example of that genus. This, however, is far from correct, that species being the type of the genus *Verticordia* and a *Miocene* shell; while *Hippagus isocardoides*, Lea, a widely distinct form, from the Eocene, is the type of *Hippagus*, and belongs, as we think, to the *Mytilidæ*, very near the genus *Crenella*, if it is indeed even generically distinct.

² If *Nucunella*, and *Nuculocardia*, D'Orbigny, are distinct from *Stalagmium*, they should apparently be placed at least near that group in the *Mytilidæ*. Chenu, in the work above cited (p. 181), places *Nucunella* in the *Arcidæ*, and figures its type, *N. Nystiæ*, both there and on p. 153, under *Crenella*, in the *Mytilidæ*.

Genus *VOLSELLA*, SCOPOLI.¹

Synon.—*Volsella*, SCOPOLI, Intr. Hist. Nat. 1777, 397.—MODEER, K. Vet. Ac. Handl. 1793, 392.—GRAY, Proceed. Zool. Soc. Lond. 1847, 197.

Tamarindiformis, MEUSCH. (part), Mus. GERVES, 1787, 412.

Callistriche and *Callistrichoderma* (sp.), POLI, Utr. Sic. I, 1791, 194.

Modiolus, LAMK. Prodr. 1799, 87.—CUVIER, Anat. Comp. 1800; Regne An. II, 1817, 471; and ib. III, 1830, 136.—LINK, Rost. Samml. III, 1807, 146.—GOLDF. Zool. 1820, 611.—RISSO, Hist. IV, 1826, 323.—FORBES, Mal. Mon. 1838, 43, &c.

Modiola, LAMK. Syst. An. 1801, 113; Id. An. du Mus. VI, 1805, 119; and Hist. VI, 1819, 109.—FERUSS. Tab. Syst. 1821, p. xlii.—BLAINV. ("Modiole"), Diet. Sci. Nat. XXXII, 1824, 318.—BRONN, Leth. 1837, 355, &c. &c.

Amygdalum, MÜLLER, Entw. 1811, 69.

Mytilus (sp.), SCHUM. Essai, 1817, 106, and various others.

Brachydontes, SWAINSON, Malacol. 1840, 384.

Etym.—*Volsella*, a kind of forceps or tweezers.

Type.—*Mytilus modiolus*, LINN.

Shell transversely oblong; surface smooth, concentrically striate, or with radiating or divaricating striæ or costæ; epidermis often produced into long filaments. Beaks depressed, and placed near the anterior extremity. Hinge sometimes a little callous and crenated, but without proper teeth; ligament linear, occupying a marginal groove. Muscular impressions very unequal; pallial line faintly marked.

Animal with mantle margins open, plain, protruding in the branchial region; anal tubes short, more or less complete; palpi triangular; byssus fine and strong.

This genus, as here defined, embraces two sections or subgenera: 1. The typical species, with a smooth or striate surface, and a non-crenated hinge; 2. Species with radiating or divaricating costæ or striæ, and a crenated hinge-margin (*Brachydontes*, Swains.). *Adula*, of H. & A. Adams, is also sometimes included as a third section, but it seems to be sufficiently distinct to rank as a separate genus.

The genus *Volsella*, or *Modiolus*, is nearly related to *Mytilus*, but differs in having the beaks obtuse and placed more or less back from the anterior end, instead of being pointed and quite terminal. The antero-basal region of these shells is also always more prominent than in the *Mytili*. There are likewise some differences in the habits of these two genera.

Species have been referred to this genus from the Silurian rocks, but they doubtless all belong to *Modiolopsis*, *Orthonota*, and other extinct genera.

Several species presenting the external appearance of *Volsella* have also been described from the Devonian and Carboniferous rocks, but we yet want a more accurate knowledge of their hinge and interior, before we can be quite sure they are true *Volsellas*. The genus seems to be represented in the Triassic rocks, and its existence during the deposition of the Jurassic system of strata is well known. It

¹ Scopoli's first species of *Volsella* was *Mytilus modiolus*, Lin., the type of the subsequently proposed genus *Modiolus*, or *Modiola*, of Lamk.; while the others belong to the older genus *Mytilus* proper, of Lin. As Scopoli was a strictly binomial author, however, the law of priority compels us to adopt his name for the previously unnamed group, of which *Mytilus modiolus*, Lin., is the type. For a regularly proposed name cannot be wholly ignored, because the author happened to include some species belonging to an older genus.

also occurs in the Cretaceous and Tertiary deposits, and is abundantly represented in our existing seas, where it probably attains its maximum development. The recent species are chiefly found in southern latitudes, though a few occur on the coast of Great Britain, and in the Mediterranean and Arctic seas; also on the eastern coast of the United States, &c.

Volsella pertenuis.

(PLATE III, Fig. 5, 5a.)

Mytilus pertenuis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 51.

Comp. *Modiola minuta*, QUENSTEDT, Der Jura, tab. i, fig. 36.

Volsella pertenuis, MEEK, Smithsonian Check List N. Am. Jurass. Foss. 1864, 28.

Shell small, very thin and fragile, narrow oblong-oval, slightly arcuate; valves convex along the middle, from near the beaks obliquely backward, in the direction of the lower part of the posterior end. Extremities narrowly rounded, the anal end being a little broader than the other; base slightly arched behind the middle. Hinge nearly straight, and apparently rather less than half the length of the shell; dorsal margin forming a broad descending curve from the back extremity of the hinge posteriorly. Beaks small, subangular, and located at the anterior end, scarcely projecting beyond the margin. Surface marked by fine, rather obscure, lines of growth.

Length, 0.73 inch; breadth, 0.26 inch; height, 0.30 inch.

This shell is so very similar to a Jurassic species figured by Quenstedt (Der Jura, tab. i, fig. 36), under the name of *Modiola minuta*, that, after further comparisons, we are at a loss to point out any characters by which it can be distinguished. As there seems, however, to be some reason to doubt the identity of the shell figured by Quenstedt with *M. minuta* of other authors, we have concluded to retain our name, *pertenuis*, until authentic specimens of these shells can be compared.

The species now under consideration is also similar in form to young specimens of *Mytilus Meekii*, Evans & Shumard (Trans. St. Louis Acad. Sci. vol. i, p. 40), but is shorter in proportion to its height. The fact, too, that *M. Meekii* is an upper Cretaceous species, while that now before us occurs in rocks holding a rather low position in the Jurassic system, is conclusive evidence, we think, that they must differ specifically.

If Adanson's ante-Linnæan genera are to be adopted, with his first species of each as its type, the name of our shell would have to be written *Perna pertenuis*, as it belongs to the same group as the type of *Perna*, of that author (not of Brug., Oken, or Cuv.). If, on the contrary, neither *Perna*, Adanson, nor *Volsella*, Scopoli, should be retained, we must adopt *Modiolus*, Lamarck, and call it *Modiolus pertenuis*.

Locality and position.—Southwest base of the Black Hills, in the lower Jurassic of that region. (Type 215.)

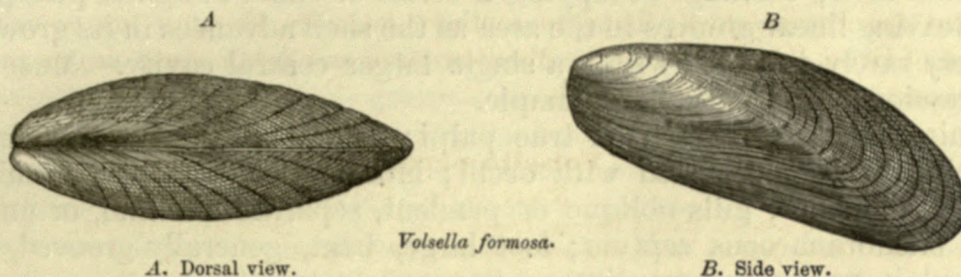
Volsella formosa.

Modiola (Perna) formosa, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1861, 439.

Volsella formosa, MEEK, Smithsonian Check List N. Am. Jurass. Fossils, 1864, 28.

Shell elongate-subelliptical, a little arcuate, gibbous along the oblique umbonal slopes, from the beaks to the postero-basal extremity; greatest convexity near the middle of the valves. Ventral margin somewhat sinuous near the middle, or a little behind it, and rounding up rather abruptly at the extremities; dorsal outline broadly arcuate, declining from the middle posteriorly; both extremities rather narrowly rounded. Beaks small, somewhat compressed, obtuse, and located directly over the anterior margin, beyond the outline of which they scarcely project. Surface ornamented with small concentric striæ, and a few stronger marks of growth, which are crossed on the dorsal and postero-dorsal regions, by regular, closely arranged, and generally simple radiating lines. Faint traces of another system of extremely fine striæ may be also sometimes seen by the aid of a magnifier, crossing the somewhat compressed ventral region of the valves, from the oblique umbonal ridge, nearly at right angles to basal margin.

Length, 2.05 inches; diameter from the dorsal margins, at right angles to the length, near the middle of the shell, 0.84 inch; greatest convexity at the same point, 0.80 inch.



A. Dorsal view.

B. Side view.

This species belongs to the irregularly proposed genus *Perna*, Adanson, = *Modiolus*, Lamarck, and will fall into Swainson's section *Brachyodontes*. It seems to be very closely related to the European *Volsella cancellata* (= *Mytilus cancellatus*, Goldfuss, Petref. Germ. tome ii, pl. 131, fig. 2), and may possibly prove to be identical, when we can have an opportunity to compare a good series of each. The five or six specimens, however, of the form here described, that we have seen, all present the following differences from Goldfuss' figure: In the first place they are narrower from the dorsal to the ventral margins, more narrowly rounded at the posterior extremity, and have slightly more prominent beaks; while their antero-ventral region is a little more convex, and their basal outline more arcuate. The surface markings of the species under consideration are very similar to those of Goldfuss' species, though his enlarged figure represents the concentric striæ crossing the radiating lines as being more distinct and regular than on our shell. Again, he neither figures, nor mentions in his description, the fine obscure transverse striæ seen on the ventral half of our species, though these are so indistinct that they might be easily overlooked; indeed they seem to be rather dependent, in some way, upon the structure of the shell, than properly surface markings.

We observe D'Orbigny cites *Modiola cancellata*, of Roemer, and his own *M. Strajeskiana*, from the Jura of Russia, as synonymous with *Mytilus cancellatus*, Goldfuss. Without knowing to what extent Goldfuss' species may vary, we cannot feel prepared to express a positive opinion in regard to its relations to the forms named by Roemer and D'Orbigny; though judging by their figures, we would be inclined to doubt the identity of these shells. At any rate, Roemer's and D'Orbigny's figures are very unlike the form now before us, which is remarkably uniform in its characters.

Locality and position.—From the Jurassic beds of Big Horn Mountains, Dakota Territory. (Type 1882.)

FAMILY ARCIDÆ.

Shell equivalve or subequivalve, not pearly within, closed or gaping below, usually gibbous; surface frequently ornamented with radiating costæ or striæ. Hinge straight or arched; provided with a more or less elongated posterior and anterior lateral tooth, which are divided transversely, obliquely, or longitudinally, into small interlocking, short, or

linear plates. Ligament external, attached to a more or less developed cardinal area; cartilage occupying a series of small marginal pits (usually leaving linear grooves in the area as the shell advances in its growth), or very rarely collected within a single larger central cavity. Muscular impressions two; pallial line simple.

Animal without siphons or true palpi; mantle margins open, simple or fringed, often provided with ocelli; labia formed of the extremities of the branchiæ; gills oblique or pendent, separated behind, or united to a membranaceous septum; foot large, bent, generally grooved, and with plain or crimped margins.

As was first observed by Dr. Gray, the hinge in this and some allied families, although in most cases apparently provided with a numerous series of small teeth, has really but a posterior and an anterior tooth, which are divided vertically, obliquely, or horizontally into small, more or less numerous interlocking plates. These divisions, Dr. Gray thinks, are analogous to the transverse ridges produced by the striæ or furrows in the teeth of *Trigonia*. In the typical Arks (that is, viewing *A. Noë* as the type), and some of the other genera, the divisions of the teeth cut the hinge margin nearly or quite at right angles, but they are found to become more and more oblique, as we pass from group to group, until in *Cucullæa*, *Macrodon*, &c., they range, particularly behind the beaks, parallel to the cardinal margin.

The family *Arcidæ*, including the various fossil and recent genera, seems to embrace three, and possibly four, more or less marked subfamilies, distinguished mainly by the arrangement of the cardinal plates, and partly by the general form and obliquity of the shell, &c. These subfamilies may be arranged and characterized as follows:—

1. *Arcinæ*.

Shell more or less oblong, or subrhombic; umbonal axis oblique, hinge margin straight or more or less arched; cardinal plates crossing the hinge margin at various angles, or rarely dividing it horizontally near each extremity.

Includes *Arca*, *Barbatia*, *Striarca*, *Anadara*, *Senilia*, *Lunarca*, *Argina*, *Noëtia*, *Litharca*, *Parallelepipedum*, *Scaphula*, *Cucullæa*, and probably *Isoarca*? and several undefined fossil genera. (*Palæozoic*? to modern seas.)

2. *Macrodontinæ*.

Form, hinge line, and umbonal axis, generally much as in the *Arcinæ*. Anterior hinge plates crossing the cardinal margin obliquely forward and upward; posterior plates ranging parallel to the hinge line, often long and linear; mesial plates obsolete.

Includes *Macrodon*, *Grammatodon*, *Cypricarditis*, and probably *Vanuxemia*,¹ *Megalomus*, *Megambonia*, *Dolabra*, and some undefined genera. (*Palæozoic* to *Jurassic*.)

3. *Axininæ*.

(a.) Shell orbicular, or suborbicular; cartilage as in *Arcinæ*; umbonal axis nearly vertical; hinge line regularly arched; cardinal plates short, and arranged as if radiating from an imaginary point below the hinge. Includes *Axinæa*.

(b.) Form and hinge as in subsection (a.). Cartilage occupying a single pit at the middle of the hinge. Includes *Limopsis*.

¹ If *Megalomus*, Hall, 1852, *Vanuxemia*, Billings, 1858, and *Megambonia*, Hall, 1859, are, as is thought to be the case, all synonymous, then the rules of priority would compel us to adopt the name *Megalomus* for the group. Until the relations of these proposed groups have been more clearly determined, it is probably better to retain them all, provisionally, as distinct genera.

We are aware these divisions are not equally distinct, the *Macrodontinæ* and *Arcinæ* being more nearly related through *Cucullæa*, *Scaphula*, &c., than either of these groups is to the *Axininæ*. Still, we find the Jurassic group *Macrodon* shading off so gradually through *Grammatodon*, *Dolabra*, *Cypricardites*, &c., to *Vanuxemia*, and other Palæozoic groups—some of which depart so widely from the recent Arks as to be scarcely recognized as belonging to the same family—that these forms seem to stand together as a distinct subfamily. At a first glance it might be thought the genus *Cucullæa* should be included in the *Macrodontinæ*; but on a closer inspection, it will be observed that in that genus the hinge always differs from these older groups, in never having the anterior hinge plates ranging obliquely forward and upwards, and at the same time the posterior ranging parallel to the hinge line. Again, the posterior hinge plates are never so disproportionately elongated in *Cucullæa* as in the older groups, while it also differs in having small vertical, mesial plates or denticles between the posterior and anterior divisions. At the same time that these differences exist between the genus *Cucullæa*, and all the allied genera included in the subfamily *Macrodontinæ*, *Cucullæa* is found to be connected by such an unbroken series, through various fossil and recent forms, with the typical *Arcinæ*, that it seems unnatural to separate it and the most nearly allied genera into a distinct subfamily.

SUBFAMILY MACRODONTINÆ.

Genus GRAMMATODON, MEEK & HAYDEN.

Synon.—*Cucullæa* (sp.), QUENSTEDT, Der Jura, 1856.

Arca (*Cucullæa*) sp. MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 51.

Grammatodon, MEEK & HAYDEN, ib. Oct. 1858, 419.

Etym.—*γραμμή*, a line; *ὀδὼν*, a tooth, in allusion to the linear teeth.

Type.—*Arca* (*Cucullæa*) *inornata*, MEEK & HAYDEN.

Animal unknown. Shell longitudinally oblong, or rhombic oval, nearly or quite equivalve, inequilateral; valves rather gibbous, and without crenulated margins; umbones somewhat depressed, incurved, and not very widely separated. Ligament area rather narrow; hinge straight, provided in each valve with a few elongated, linear posterior cardinal plates, arranged parallel to the hinge margin; and a greater number of shorter, oblique anterior plates in front of the beaks. Pallial line obscure; muscular impressions faintly marked, and without a projecting lamina or ridge. Surface nearly smooth, or with obscure radiating costæ or striæ.

The species upon which we propose to found this genus agrees almost exactly, in the character of its hinge, with *Macrodon* of Lycett; but is proportionally much shorter, and differs in having its pallial margin smooth, and closed, instead of crenulated and gaping. Its beaks are also located farther back, while its muscular impressions differ in being destitute of any ridge or prominence, such as we see in *Macrodon* and *Cucullæa*. Possibly it may be only a subgenus under *Macrodon*.

It is but necessary, we think, to compare the hinge of such forms as these with

that of the recent *Arca Noæ*, usually regarded as the type of the genus *Arca*, to be satisfied that they cannot be included in the same group, in accordance with correct rules of classification.

The group under consideration will probably include several other Jurassic, and possibly a few Cretaceous species, though we cannot, with any degree of confidence, attempt to define its exact geological range.

Grammatodon inornatus.

(PLATE III, Fig. 9, 9a, 9b.)

Arca (Cucullæa) inornata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 51.

Grammatodon inornatus, MEEK & HAYDEN, Ib. Oct. 1862, 419.

Comp. *Cucullæa Munsteri* (ZEITEN), QUENSTEDT, Der Jura, tab. 13, fig. 38; tab. 18, fig. 34; tab. 23, fig. 8.

Shell subrhomboidal, or oblong-oval in outline, rather gibbous in the umbonal region. Anterior end rounding up from below, and forming an angle of about ninety degrees with the hinge line above; posterior side a little broader than the other, obliquely truncate above, and somewhat narrowly rounded below; base nearly straight along the middle, but not exactly parallel to the hinge line, rounding up more gradually in front than behind. Beaks rising somewhat above the hinge, incurved, and very slightly oblique, located a little in advance of the middle; posterior umbonal slopes prominently rounded. Hinge comparatively long, but not quite equalling the greatest length of the shell; posterior hinge-plates three or four in each valve; anterior much shorter, and usually numbering about six or seven. Ligament area not very broad. Surface apparently smooth.

Length, 0.75 inch; height, 0.45 inch; breadth, 0.46 inch.

Quenstedt figures several forms similar to this under the name of *Cucullæa Munsteri*, in his "Der Jura," though none of them appear to agree exactly with our shell. The true *C. Munsteri*, as figured by Goldfuss (Petrefact. Germ. tab. 122, fig. 10), differs, at least from our species, in having a rather distinct ridge along the cardinal margin. All of our specimens also appear to be entirely destitute of radiating striæ; though there may be very fine radiating lines, where the surface is well preserved.

Locality and position.—Southwest base of Black Hills, associated with other Jurassic fossils. (Type 201.)

FAMILY UNIONIDÆ.

Shell equivalve, inequilateral, regular, smooth, plicate or tuberculate, nacreous within; epidermis thick, covering a prismatic cellular layer; margins closed and smooth within; ligament external. Hinge varying with the genera and subordinate groups. Muscular impressions deep; pedal scars three in each valve, two behind the anterior adductor, and one before the posterior; pallial line simple.

Animal with mantle margins disconnected, excepting between the anal and branchial regions; not produced into siphonal tubes, but fringed in the branchial, and usually plain in the anal regions. Foot very thick, tongue-shaped, often byssiferous in the young, but rarely so in the adult. Gills elongate, subequal, free or connected with the mantle or abdominal sack behind. Labial palpi usually united behind.

Conchologists differ very widely in regard to the number of generic and sub-generic heads under which the numerous species included in this family should be

arranged. The following are the names of the genera most usually admitted by late writers, viz.: *Unio*, *Anodonta*, *Byssanodonta*, *Margaritana*, *Monocondylæa*, and *Barbala*. Prof. Agassiz, however, who has dissected, with much care, many of our American species, finds that they present marked differences in the arrangement of the gills, and the position of the eggs in the same, as well as in other anatomical details, from which he is led to the conclusion that there are at least twenty-two distinct genera amongst our species usually referred to *Unio*, *Anodonta*, *Alasmodonta*, and *Margaritana*. For these groups he has adopted the following names, viz.: *Dysnomia*, Ag.; *Scalenaria* (Raf.), Ag.; *Truncilla* (Raf.), Ag.; *Lampsilis*, Raf.; *Cunthyria*, Swainson; *Eurynia*, Raf.; *Metaptera*, Raf.; *Alasmodonta*, Say; *Obovaria*, Raf.; *Micromyu*, Ag.; *Cyprogenia*, Ag.; *Plagiola*, Raf.; *Orthonymus*, Ag.; *Tritogonia*, Ag.; *Quadrula*, Raf.; *Rotundaria*, Raf.; *Complanaria*, Swainson; *Pleurobema*, Raf.; *Uniopsis*, Swainson; *Margaritana*, Schumacher; *Hemilasterna*, Raf., and *Unio*, Retz.¹

Mr. T. A. Conrad, of Philadelphia, who admits many of these groups as subgenera under *Unio*, also proposes to adopt the following additional subgenera, mainly for the reception of foreign species, viz.: *Nodularia*, Con.; *Iridea*, Swainson; *Mysca*, Turton; *Lanceolaria*, Con.; *Cœlatura*, Con.; *Cunicula* (Sw.), Con.; *Glebula*, Con.; *Uniomerus*, Con., and *Theliderma*, Swainson. The following he proposes as full genera: *Cucumaria*, Con.; *Hyriopsis*, Con., and *Monodontina*, Con.

As an example of the widely different views entertained by authors in regard to the classification of these mollusks, we should remark that Dr. Isaac Lea, who has given more attention to the study of the *Unionidæ* than perhaps any other person, includes the whole, along with some others not generally admitted in this family, under two generic heads, for which he adopts the names *Margaron* and *Platiris*. Under the first of these he ranges as subgenera, *Triquetra*, *Prisodon*, *Unio*, *Margaritana*, *Monocondylæa*, *Anodonta*, and *Dipsas*; and under the second *Iridina*, *Spatha*, and *Mycetopus*.²

Mr. Niclin went still farther in this direction, and included *Unio*, *Anodonta*, *Alasmodonta*, *Iridina*, *Dipsas*, *Hyria*, and *Castalia* as members of a single genus!³

The family *Unionidæ* has a wide geographical distribution, but is most numerously represented in the streams of North America. Although apparently represented as far back as the Jurassic period, it is pre-eminently characteristic of the present epoch, since the species and genera are far more numerous now than they were during any of the past geological periods. The existing species also present much greater diversities of form and ornamentation, and sometimes attain larger sizes than are known to occur amongst those now extinct.

¹ Weigmann's Arch. 1852, p. 41.

² Synopsis Naïdes, 3d ed. Phila. 1852.

³ Trans. Phil. Soc. VIII, p. 398.

Genus UNIO, RETZIUS.

*Synon.*¹—*Unio*, RETZ. Diss. Phys. 1788, 16.—BRUG. Jour. d'Hist. Nat. 1792, and Encyc. Méth. I, tab. 247.—Cuv. Tab. Elem. 427.—LAMK. Prod. 1799, 87, and Syst. 1801, 114.

Mya, HUMPHREY, Mus. Coll. 1797, 59 (not LINN.).

Limnium, OKEN, Lehrb. d. Natnrg. III, 1815, and 1821, Naturg. f. Schul. 651, 8.

Ellipto, RAF. Jour. Phys. tom. 88, 1819, 426, and 1820 Monogr. Bivalves of the Ohio. . . .

Margarita (part), LEA, Trans. Am. Phila. Soc. VI (n. s.), 1 (not LEACH, 1819).

Cunicula, SWAINSON, Malac. 1840, 267, and 378.

Margaron (part), LEA, Synop. Naid. (3d ed.), 1852, p. xvii.

Etyim.—*Unio*, a pearl.

Type.—*Mya pectorum*, LINN.

Shell variable in form, usually oval, elongate or oblong; surface covered with a brownish or olivaceous epidermis, sometimes striped with greenish and olive bands. Beaks often eroded. Nacre white, yellowish, flesh-colored, or purple. Hinge variable, generally with two anterior teeth in one valve, and one in the other, or two in each; posterior teeth elongate and laminar, usually two in one valve and one in the other.

Animal, in the typical species, with gills free from the abdominal sac, their posterior extremity attached to the mantle; eggs in the female filling the whole extent of the outer gill; mantle fringed at both syphonal openings. (Agassiz.)

As above restricted, it will be rather difficult to determine the geological range of the genus *Unio*, since some of its more important distinctive characters are such as belong to the softer parts of the animal only. The oldest known species apparently belonging to this genus have been described from the Jurassic rocks, though it is somewhat doubtful whether these are true Uniones. It was formerly supposed that some Carboniferous and Devonian shells belonged to this genus, but they are now all known to belong to *Cardinia*, *Carbonocola*, and other extinct groups. Several species apparently presenting the characters of this group have been described from the Wealden beds, but this type of life seems not to have been very generally distributed over the world until the Tertiary epoch; and it undoubtedly attains its greatest development at the present time, and in the streams of this country. (Type 192.)

Unio nucalis.

(PLATE III, Fig. 13, *a*, *b*, *c*.)

Unio nucalis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, p. 52.

Shell longitudinally oval, gibbous in the central and umbonal regions. Anterior extremity rather narrowly rounded; base semi-oval, sometimes rather prominent near the middle; posterior end subtruncate, or forming a regular curve from above, and rather narrowly rounded below. Beaks moderately depressed, located about half way between the middle and the anterior end, not eroded; posterior umbonal slopes prominently rounded. Surface marked by fine obscure concentric lines, and more or less distinct marks of growth; the latter becoming small, and very regular wrinkles on the beaks.

Length, about 1.63 inch; height, 1.05 inch; breadth, 0.82 inch.

¹ A number of the names mentioned in connection with the family *Unionidæ* are doubtless only synonyms of *Unio*; but until the limits of this genus have been more satisfactorily determined, it is probably better to include only those more exactly synonymous with the genus as restricted to the typical forms.

Although apparently associated with an *Ammonite* (*A. Henryi*), and a small *Ostrea*, this shell seems to present, as far as we have been able to see, the characters of a true *Unio*. We are the more inclined to regard it as belonging to that genus, in consequence of the fact that we also find in the same matrix a small *Planorbis*, and apparently a *Valvata*, and a *Viviparus*. None of our specimens show the hinge very satisfactorily, though in one left valve (Pl. III, Fig. 13, c.) it is seen to be rather thick, a little arched, and provided with a long, posterior lateral tooth, extended parallel to the cardinal margin, from which it is separated by a deep groove, for the reception of a similar tooth in the other valve. The anterior tooth is compressed, irregular, somewhat corrugated, and located nearly under the beaks; while the ligament is in all respects apparently similar, in form and position, to that of our recent *Uniones*.

Specimens having the surface well preserved sometimes show very small, radiating wrinkles on the posterior side of the umbones, near the hinge; in most cases, however, these are obsolete. A small, obscure, linear ridge is also generally seen extending from the back part of each beak obliquely backward and downward, just within the prominent umbonal slopes. The minute concentric wrinkles are very regular on the beaks.

The specimens of this species we have seen were not broken directly from the rock in place, but from the composition, color, &c. of the matrix, and the circumstances under which they were found, we are led to think they occur in a Jurassic bed seen at the locality where they were found, though we are not positively satisfied they may not be Cretaceous or Tertiary species. They differ, however, specifically from any of the forms yet known in these rocks in the northwest.

Locality and position.—Southwest base Black Hills. Jurassic. (Type 196.)

FAMILY CRASSATELLIDÆ. (See page 34.)

Genus ASTARTE, SOWERBY.

Synon.—*Astarte*, J. SOWERBY, Min. Conch. II, 1816, tab. 137.—LAJONKAIRE, Monogr. in Mém. Soc. de Hist. Nat. de Par. I, 1823, 129.—FLEMING, Brit. An. 1828, 409.—RANG. Man. 1829, 314.—DESHAYES, Encyc. Meth. II, 1830, 76; III, 553.—SCACCHI, Osservaz. Zoolog. 1833, No. 2.—BRONN, Leth, 1837, 374.

Tridonta, SCHUM. Essai, 1817, 146.—MOLLER, Isis, 1832, 135.

Crassina, LAMK. Hist. Nat. V, 1818, 554.—FERUSSAC, tab. Syst. 1821, p. xlii.—SCHWEIGG, Natgesch. 1820, 710.—BLAINV. Malacol. 1825, 557.

Nicania, LEACH, Jour. Phys. I, 1819, 88, 465.—BLAINV. Malacol. 1825, 558.

? *Goodallia*, TURTON, Brit. Bivalves, 1822, 77.—FLEMING, Brit. An. 1828, 409 and 429.—FORBES, Malac. 1838, 48.

Maetrina, BROWN, Brit. Conch. 1827, tab. xvi; and Conch. Text-Book, 1833 (VI ed. 159).

Etym.—*Astarte*, the Syrian Venus.

Examp.—*Venus Danmoniensis*, MONT.

Shell oval, subtrigonal, or suborbicular, thick, usually compressed, closed. Surface smooth, or marked with concentric striæ or undulations; ligament external; lunule generally well defined. Hinge with two strong diverging primary teeth in one valve, and one or two in the other. Impressions of the adductor and pedal muscles deep and well defined; pallial line simple.

A few species have been referred to this genus from Devonian and Carboniferous

rocks, but too little is known in regard to the hinge and interior of these shells to warrant the conclusion that they are beyond doubt true *Astartes*. Two species, described by Prof. King, from the Permian rocks of England, possess the external characters of this genus, and one of them, at least (*A. Vallisneriana*), as since figured by Prof. Geinitz (Dyas. Pl. 12, figs. 24 and 25), seems also to present the dentition of the *Astartes*.

From the Trias, Prof. F. M. Roemer has described three species of *Astarte*, and several are known from the Liassic rocks. In the later members of the Jurassic system, particularly in the Oolites, the species are quite numerous. The genus also ranges through the succeeding formations, and probably reached its greatest development during deposition of the Tertiary rocks. It is, however, well represented in the seas of the existing epoch. The recent species are usually found in northern latitudes. They occur on the shores of North America, Northern Europe, Norway, Greenland, &c.

Astarte fragilis.

(PLATE iv. Fig. 7.)

Astarte fragilis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 183.

Shell small, rather broad oval, thin, moderately compressed. Anterior end rounded; base nearly straight along the middle, rounding up regularly in front, and more abruptly behind; posterior extremity obscurely subtruncate; dorsum straight and slightly declining behind the beaks, which are small, obtuse, rather depressed, and located a little in advance of the middle. Posterior umbonal slopes prominent. Surface ornamented by distinct, irregular concentric wrinkles, and fine parallel striae. (Hinge and interior unknown.) Pallial margins crenulate.

Length, 0.45 inch; height, 0.32 inch; breadth, about 0.18 inch.

The rather unusual thinness and oval form of this little shell lead us to doubt whether it can be a true *Astarte*, though even in this respect, as well as in its other characters, it is evidently quite similar to some Jurassic forms generally placed in that genus.

In several respects it resembles quite closely the small thin variety of *A. excavata*, Sowerby sp., figured by Morris and Lycett in their monograph of the English Oolitic fossils, pl. 9, fig. 19 (Palæont. Soc.), but its beaks are located further back, and its posterior margin is narrower and more oblique; while its lunule does not seem to be excavated as in that species.

Locality and position.—Southwest base of the Black Hills, in the lower Jurassic beds of that region. (No. 194.)

Astarte inornata.

(PLATE III, Fig. 12, a, b.)

Astarte inornata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 183.

Shell subelliptical, compressed; extremities rounded, the posterior margin forming a broader curve than the other. Base semi-elliptical in outline; dorsum declining from the beaks, the anterior slope being a little concave, and the other nearly straight, or slightly convex. Beaks moderately elevated, compressed, located just in advance of the middle. Lunule rather deep, lance-oval, bounded on each side by a more or less distinct angle. Surface marked by concentric striae, with a tendency to develop small, very obscure concentric wrinkles.

Length, 1.15 inch; height, 0.79 inch; breadth, about 0.44 inch.

We only place this shell in the genus *Astarte* from its similarity to several Jurassic species of that group, not having seen its hinge or interior.

Locality and position.—Same as last. (No. 202.)

FAMILY TANCREDIIDÆ.

Shell oval-subtrigonal, longer than high, never very gibbous, equivalve, subequilateral, nearly smooth; valves gaping or closed; hinge with cardinal, and usually posterior lateral teeth; muscular impressions moderate, smooth; pallial line simple; ligament external, or probably sometimes partly internal.

Animal unknown.

The genus *Tancredia* presents a combination of characters that seem to forbid its admission into any of the established families of *Lamellibranchiata*. Until the affinities of this and some little known fossil shells, apparently not more than generically separated from it, can be better determined, it has been thought preferable to propose a distinct family for their reception. It is perhaps most nearly related to the *Cardiidae* (in which some authors place it) than to any other family, though the more elongate, compressed, Donaciform outline and smooth surface of these shells give them a peculiar physiognomy, very unlike any of the genera known to belong to that family; while some of the closely related fossil forms belonging apparently to one or more undescribed genera are known to be distinctly gaping in front, as well as behind, a feature unknown in the *Cardiidae*.

Their simple pallial line, and external ligament, would exclude these shells from the *Macridæ*, which they resemble in form; while the former of these characters shows that they cannot be placed in the *Tellinidae*. Their general physiognomy, not less than their comparatively small, smooth muscular scars, show that they cannot be properly included in the *Lucinidae*, to which they are often referred.

This family, in addition to the typical genus, includes the recently proposed genus *Meekia*, of the Cretaceous rocks of California.

Genus TANCREDIA, LYCETT.

Synon.—*Donax*, *Macra*, &c. (sp.) of DUNKER, DESHAYES, D'ORBIGNY, and others.

Tancredia, LYCETT, Ann. Mag. Nat. Hist. vi, 1850, 407.—MORRIS and LYCETT, Moll. Great Oolite, 1853, 90.

Hettangia, TERQUEM.—BUVIGNIER, Statist. Geol. Mineral. et Paléont. du Dept. de la Mus. 1852, Atlas, 14.—TERQUEM, Bul. Soc. Geol. Fr. tom. 10 (2^e sér.), 1853, 364.

Etym.—Dedicated to Sir Thomas Tancred.

Type.—*Tancredia donaciformis*, LYCETT.

Shell depressed subtrigonal, or longitudinally subovate, rather compressed, without a defined lunule; basal margin semi-ovate or semi-elliptical in outline, not crenate within; posterior side wider and more convex than the other, sometimes gaping; anterior side more or less attenuate or pointed, and closed; beaks subcentral, usually small, contiguous; ligament short, external, occupying a small depression. Hinge with one obtuse cardinal tooth in each valve, fitting into a corresponding cavity in the other; sometimes a small accessory cardinal tooth at the anterior side of the cavity in the right valve, and on the posterior side in the left. Lateral teeth large, obtuse posterior, that of the left valve prominent, and fitting into a depression in the tooth or callosity of the other valve. Muscular impressions oval; the simple

pallial line obscure, and remote from the margins. Margin of the right valve in front of the beaks, somewhat thickened, slightly projecting, and received into the margin of the other valve, though there are no proper anterior lateral teeth.

This genus dates back to the Liassic period; some ten or twelve species having been identified by M. Buvignier and M. Terquem, in rocks of that age, in France. So far as we are acquainted, it has not yet been recognized above this horizon on the continent, while in England it is only known in the lower Oolite. In America it ranges still higher, a single well-marked species having been described by us from Cretaceous beds, at the mouth of Judith River, on the Upper Missouri. In this country it also made its first appearance in Jurassic rocks.

This genus is closely allied to the Cretaceous genus *Meekia*, Gabb (Palæont. California, I, 1864, 191), but differs in always having the anterior side closed instead of gaping, as well as less angular. There are also some differences in the hinge plate; while the ligament in *Meekia* is said to be only "subexternal."

Tancredia Warrenana.

(PLATE III, Fig. 7.)

Tancredia Warrenana, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 183; ib. Oct. 1860, 418.

Shell small, trigonal ovate, moderately convex; anterior half a little narrower and more compressed than the other, narrowly rounded at the extremity; base forming a broad gentle curve; posterior side subtruncate, angular, or very abruptly rounded below. Dorsum sloping from the beak; the anterior slope being slightly concave in outline, and the other nearly straight, or a little convex. Beaks rather elevated, but not extending much above the cardinal edge; posterior umbonal slopes prominent or subangular. (Surface and hinge unknown.)

Length, 0.50 inch; height, 0.33 inch; breadth, about 0.14 inch.

We have not yet had an opportunity to see the hinge or the pallial line of this shell, and consequently only place it provisionally in the genus *Tancredia*. Its form, however, is such as to leave little room for doubt in regard to its relations to that group. As our specimens are casts, they do not give a very clear idea of the surface, though it seems to have been only marked by lines of growth. It is only the immediate extremity of the posterior margin that appears to be a little truncated vertically. Our specimens do not show whether the valves were gaping behind or not, but they have the appearance of being closed.

This species resembles more or less closely several of those figured by Morris and Lycett in their monograph of the fossils of the Great Oolite, but seems to differ specifically from them all, as well as from those figured by Terquem and other continental authors. It agrees most nearly in size and general appearance with *T. brevis*, Morris and Lycett (Mol. Gt. Oolite, part 3, fig. 8, pl. xiii, Palæont. Soc.), but is higher in proportion to its length, and more rounded at the extremities.

Locality and position.—Jurassic beds at southwest base of the Black Hills. (No. 204.)

Tancredia? æquilateralis.

(PLATE III, Fig. 8.)

Tancredia? æquilateralis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 183; ib. Oct. 1860, 418.

Shell very nearly elliptical, moderately convex; anterior end rather narrowly rounded; base forming a broad regular, semi-elliptic curve; posterior end slightly truncate on the upper oblique slope, narrowly rounded below, and apparently not gaping. Beaks depressed, located a little in advance of the middle. Surface of cast retaining traces of concentric striae. (Hinge and interior unknown.)

Length, 1 inch; height, 0.64 inch; breadth, about 0.16 inch.

The specimens of this species in the collection are casts, in a rather soft yellowish sandstone, showing neither the hinge nor the muscular and pallial impressions. Consequently we have no means of determining with much confidence to what genus it properly belongs. In form and general appearance it resembles some species of the above group, and the cast shows an impression behind the beaks, such as would be left by a posterior tooth or callus similar to that seen in many species of *Tancredia*.

Locality and position.—Jurassic beds at southwest base of the Black Hills. (No. 298.)

FAMILY CARDIIDÆ.

Shell free, regular, equivalve, usually cordiform and gibbous; margins closed or gaping posteriorly, crenate or dentate within; surface generally with radiating costæ, or variously sculptured, sometimes smooth. Hinge more or less variable, usually with cardinal and lateral teeth; ligament external, short and prominent. Pallial line simple, or slightly sinuous.

Animal with mantle margins open in front; siphons very short, distinct, and furnished along the sides and bases with tentacular filaments; palpi slender and pointed. Gills two on each side, connected together behind. Foot very long, bent or geniculate.

The recent genera usually included in the family are *Cardium*, *Lævicardium* (or *Liocardium*), *Corculum*, and *Papyridea*. The species constituting the recent genus *Adacna* (including *Monodacna* and *Didacna*), sometimes placed in this family, seem to belong to a distinct group, on account of their elongated, plain, and united siphons, and their shorter compressed foot and deeply sinuous pallial line.

The Jurassic and Cretaceous group *Protocardia*, the Cretaceous *Liopistha*, the curious Eocene *Lithocardium*, and several unnamed extinct genera, also belong here. The remarkable palæozoic genus *Conocardium* is likewise often referred to this family, but its distinct coarsely prismatic cellular shell-structures has led some naturalists to think it may even belong to the very widely removed, anomalous order? *Rudista*. Although not prepared to adopt this conclusion, we are by no means clearly satisfied that it belongs properly to the *Cardiida*.

Genus PROTOCARDIA, BERYCH.

Synon.—*Cardium* (sp.), SOWERBY, D'ORBIGNY, and others.

Protocardia, BERYCH, Zeitschr. f. Malak. 1845, 17.—GEINITZ, Grundr. d. Verst. 1846, 421.—CONRAD, Report Mex. Bound. Survey, 1858, 150.—MEEK, Smithsonian Check List North American Cret. Fossils, 1864.

Ety.—*πρωτος*, first; *Cardium*.

Type.—*Cardium Hillanum*, SOWERBY.

Shell globose-cordate, closed all around; subequilateral and but slightly oblique. Hinge with one or two cardinal teeth, and usually one anterior and one posterior lateral tooth, in each valve. Surface ornamented with very regular concentric costæ or striæ on the sides and front of the valves, and radiating costæ behind (the

concentric markings sometimes very fine or obsolescent). Muscular impressions distinct; pallial line somewhat sinuous.

This group is nearly related to some of the sections of *Cardium*, but may be generally readily distinguished by its peculiar surface-sculpturing and slightly sinuous pallial line. Still, as its principal difference from forms referred by many to the genus *Cardium* consists in its surface-markings, most palæontologists regard it as forming only a subgenus under that group. Although we have no very serious objections to this conclusion, we think it more properly constitutes a distinct genus from *Cardium* as typified by *C. costatum*, Lin. Although it can nearly always be identified by its sculpturing alone, there are a few Cretaceous species in which these markings are very faintly defined, or probably in some case entirely obliterated. The radiating costæ or striæ on the posterior side of the valves, however, are nearly always present, even when the concentric sculpturing on the sides and front are obsolete. Very rarely, however, the radiating markings are obsolete; even in these cases, however, some traces of their existence can be seen in the crenulated margins of the posterior side of the valves.

This genus seems to be entirely confined to the Jurassic and Cretaceous rocks, unless a few recent shells, such as *Cardium pectenatum*, Lin. (not Lamk.), and *C. lyratum*, Sowerby, from the Philippines, may belong to the same group. These two species agree in form, and have very nearly the surface-markings of *Protocardia*, and unless they present some differences in the hinge or interior (we are not acquainted with the interior of these shells), they must be nearly related to the group under consideration. Still, they differ in having the sculpturing on the sides and front of the valves, somewhat oblique, and intersecting the anterior margins, instead of concentric and curving upwards in front. They were referred, by Swainson, Mörch, Chenu, Adams, and others, to *Liocardium*, but they differ materially from *C. lævigatum*, usually regarded as the type of the latter group.

Protocardia Shumardi.

Cardium Shumardi, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 182.

Cardium (Protocardium?) Shumardi, MEEK & HAYDEN, ib. 418.



Protocardia Shumardi.

A. Side view of internal cast.

B. Outline front view of same.

Shell small, oval subcordate, rather gibbous; anterior side rounded; base more broadly rounded; posterior side obliquely subtruncate above, and intersecting with an abrupt curve, the base below. Hinge margin rather short, and sloping slightly from the beaks, which are moderately elevated, gibbous, and nearly central; posterior umbonal slopes subangular. Surface of casts retaining only traces of small radiating costæ, or lines, on the prominent posterior umbonal slopes and the flattened postero-dorsal region. (Hinge and interior unknown.)

Length, 0.44 inch; height, 0.37 inch; thickness, 0.32 inch.

Our specimens of this species being casts, it is impossible to determine whether or not the surface was marked by regular concentric striæ on the middle and anterior portions, though it probably was. In its general appearance it bears some

resemblance to *C. scitulum*, Meek (Trans. Albany Inst. 1856), a Cretaceous species from Vancouver's Island, but its truncated posterior margin is more oblique, and its posterior umbonal slopes more angular.

It seems to be more nearly related to the Oolitic species *C. semicostatum*, Lycett (An. Nat. Hist. 1850), but is longer in proportion to its height, and has less distinctly angular umbonal slopes. The specific name was given in honor of Dr. George G. Shumard, formerly of the Geological Survey of Texas.

Locality and position.—Southwest base of the Black Hills, in Jurassic beds, associated with *Eumicrotis curta*, *Belemites densus*, *Grammatodon inornatus*, &c. (No. 194.)

FAMILY ANATINIDÆ. (See page 36.)

Genus MYACITES (SCHLOT.), MUNSTER.

Synon.—*Myacites* (part.), SCHLOT. Petref. 1820, 176.—BRONN, Leth. 1837, 174.—MUNSTER, in GOLDF. Petref. Germ. II, 1840, 259.—WOODWARD, Man. Moll. 1850, 322.—MORRIS and LYCETT, Moll. Grt. Oolite, 1853, 111.

Panopæa (sp.), D'ORBIGNY, Palæont. Fr. III, 1844, 329, and of various others (not Menard de la Groye, 1809).

Pleuromya, AGASSIZ, Étud. Crit. IV, 1845, 231.—LEONH. and BRONN, Jahrb. 1846, p. 122.—CHENU, Man. Conch. II, 1862, 28.

Myopsis, AGASSIZ, Étud. Crit. IV, 1845, 251.—CHENU, Man. Conch. II, 1862, 28.

Etym.—μύςξ, a mussel.

Examp.—*Myacites musculoides*, SCHLOT.

Shell longitudinally ovate, oblong, or more or less elongate, very thin, nearly or quite equivalve, without a defined lunule; more or less gibbous in the central and umbonal regions. Extremities gaping, the posterior side more than the anterior, which is often nearly closed. Beaks moderately gibbous, placed between the middle and the anterior extremity. Hinge probably always with one more or less developed cardinal tooth in each valve; cardinal margin sometimes inflected, but more generally erect, excepting near the beaks; ligament external, short. Valves often with a broad, undefined depression extending from the beaks to the basal or antero-basal margin, usually deepening and widening as it descends. Surface with concentric striæ, and often more or less regular concentric ridges or costæ, the whole being, when well preserved, usually beset with minute granules. Muscular and pallial impressions very faintly marked; sinus of the latter broad and rounded.

Animal unknown

There is some confusion in regard to the limits of this genus, some authors including in it a wide range of forms evidently belonging to several genera, while others restrict it to a few of these, or reject the name entirely, placing the species in one or more of the allied groups. The name *Myacites* has perhaps met with less general acceptance because it was not proposed by Schlotheim, who first used it, as the name of a distinct genus, but to designate certain fossil shells supposed by him to belong to the existing genus *Mya*. He merely added the termination *ites* in this as in other instances, because the species he was figuring and describing were fossils, and not because he supposed them to belong to a new genus. By examining his work, it will be seen he wrote all the names of the genera to which he referred his

fossil species in the same way; thus he ranged the fossil shells he supposed to belong to the genera *Pecten*, *Donax*, *Unio*, *Buccinum*, &c., under the names *Pectenites*, *Donacites*, *Unionites*, *Buccinites*, &c. Hence we cannot accept any of these as generic names established by him, when he may have by mistake included types of undescribed genera.

The first author, after Schlotheim, so far as our knowledge extends, who used the name *Myacites*, was Bronn (Leth. 1837); but as he used it in much the same sense that Schlotheim did—that is, as a provisional receptacle for fossil shells supposed to belong to the genus *Mya*, as he did *Turbinites*, &c.—we can scarcely regard him as having established it as a genus. In 1840, however, Munster adopted it regularly as the name of a distinct genus, and described under it *Myacites musculoides*, *M. ventricosus*, *M. elongatus*, *M. radiatus*, *M. mactroides*, Schlot.; *M. radiatus*, *M. grandis*, *M. obtusus*, Munster; and *M. Albertii*, Voltz; all of which appear to be congeneric with the first or typical species, with possibly one or two exceptions. We regard it as an established genus from that date, with *M. musculoides* as its type.

As already stated in the remarks respecting the affinities of the genus *Allorisma* (page 37), this group, as we understand it, seems to be very closely related to the Permian and Carboniferous shells upon which that genus was founded. For a statement of the principal points of difference between these two groups we would refer the reader to the remarks on page 37, in connection with the description of *Allorisma*.

These shells are also related to the genus *Pholadomya*, from which they differ in never having radiating costæ, as well as in their granulated surface. They also seem to be entirely destitute of pearly internal layer seen in the shells of that genus. From *Panopæa*, to which they are often referred, they differ in being much thinner shells, as well as in their granulated surface and much more faintly marked muscular and pallial impressions. Indeed, they appear, from all analogy, to belong even to the very distinct family *Anatinidæ*, instead of the *Saxicavidæ*.

The genus *Myacites* probably first appeared during the Triassic epoch, though we are not sure that some of the species usually referred to *Allorisma* from the older rocks are really generically distinct. It seems to have reached its maximum development during the deposition of the Jurassic rocks, and continued to exist until after the commencement of the Cretaceous epoch, during the earlier part of which it probably became extinct.

***Myacites nebrascensis*.**

(PLATE IV, Fig. 5.)

Myacites Nebrascensis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 182; ib. Oct. 1860, 418.

Shell elongate-subelliptical, rather convex; extremities narrowly rounded, the posterior end being sometimes apparently obliquely subtruncate, and more or less gaping above. Base nearly straight, or very slightly sinuous, along the middle; rounding up gradually toward the ends. Dorsum behind the beaks, concave in outline; posterior umbonal slopes gibbous, or prominently rounded; antero-ventral region a little compressed, or contracted, from near the middle of the base, obliquely forward and upward. Beaks moderately elevated, gibbous, incurved, and located near the anterior end. Surface ornamented by concentric striae, and small, very obscure, irregular parallel wrinkles.

Length, about 1.43 inch; height, 0.69 inch; breadth, 0.59.

Our specimen being a cast, has probably lost some of its finer surface characters,

though it evidently never had radiating costæ, like we see on well-marked species of *Pholadomya*, as defined by most authors. Its true generic relations, however, must remain doubtful until better specimens can be obtained.

Locality and position.—Southwest base of the Black Hills, near the lower part of the Jurassic series of that region.

Myacites subellipticus.

(PLATE IV, Fig. 6, a, b, c.)

Panopæa (Myacites) subelliptica, MEEK & HAYDEN, *Proceed. Acad. Nat. Sci. Phila.* March, 1858, 52; ib. Oct. 1860, 418.

Shell narrow, elliptical, or subovate, moderately convex; extremities rather narrowly rounded, the posterior end being more compressed than the other; base forming a very broad semi-elliptic curve; beaks located in advance of the middle, rather depressed, the right one sometimes a little more elevated than the other; surface of cast marked by small irregular wrinkles of growth; hinge and muscular and pallial impressions unknown.

Length, 2.08 inches; height, 1.09 inch; breadth, 0.70 inch.

In its general appearance this species resembles *Panopæa peregrina*, D'Orbigny, as figured by Murchison, de Verneuil and Keyserling, in their *Geol. Russ.* II, part 3, pl. xl, fig. 10, but it is proportionally a little shorter, narrower posteriorly, and more convex in the antero-ventral region, while its extremities appear to be less gaping.

It is even more nearly similar in form to *P. Neocomiensis*, Lehm. sp., from the Lower Green Sand of the Old World, but differs from most of the figures we have seen of that species, in being more narrowly rounded at the extremities, and in having less prominent beaks.

Locality and position.—Southwest base of the Black Hills, near the lower part of the Jurassic series of that region. (Type No. 200.)

Genus THRACIA, LEACH.

Synon.—*Thracia*, LEACH, MSS. 1819; BLAINVILLE, *Diet. Sci. Nat.* XXXII, 1824, 347; and *Malac.* 1825, 564.—RANG, *Man.* 1829, 324.—DESHAYES, *Encyc. Meth.* III, 1830, tab. 1832; ib. p. 1038; and in LAMK. 2d ed. VI, 1835, 82.—MENKE, *Syn.* 2d ed. 1830, 119, &c. Not *Thracia*, Westwood, 1840 (*gen. Insects*).

Odontocinetus, DA COSTA, *Cat. Syst.* 1829, 32.

Odontocineta (Corr.), AGASSIZ, *Index Universalis*, 1846, 255.

Ety.—Θράκιος, Thracian?

Type.—*Mya pubescens*, PENN.

Shell longitudinally oblong or ovate, inequivalve, rather thin; posterior side more or less contracted, compressed, and gaping; surface concentrically striate, sometimes minutely scabrous. Hinge consisting of a thick, slightly prominent cartilage process in each valve, with a free crescentic ossicle in front. Ligament partly internal. Pallial sinus rather shallow; muscular impressions small. Outer shell layer consisting of distinct nucleated cells.

The genus *Thracia* was probably introduced during the deposition of the Liassic or oldest Jurassic rocks. It also ranges through the later formations, and appears to attain its greatest development in our existing seas. The species, however, were quite numerous at several intermediate periods, particularly during the deposition of the Neocomian rocks.

We observe several authors place *Rupicola*, of Bellevue, 1802, as a subgenus

under *Thracia*, while others adopt it as a distinct genus. Whether we regard the type upon which it was founded as generically or subgenerically distinct, however, Bellevue's name should probably not be retained, since it was used by Brisson, in 1760, for a genus of birds, now adopted by ornithologists.

Thracia? sublævis.

(PLATE IV, Fig. 4, and 4a.)

Thracia? sublævis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 182; ib. Oct. 1860, 418.

Shell elongate, or narrow oblong-oval, rather compressed. Anterior end narrowly rounded; base nearly straight along the middle, rounding up toward the ends; posterior side longer than the other, rounded, or slightly truncate, and apparently gaping a little at the extremity; dorsal border straight or concave in outline, and nearly horizontal behind the beaks, declining more abruptly in front. Beaks moderately elevated, the right one being usually a little higher than the other; located in advance of the middle; posterior umbonal slopes prominently rounded. Surface concentrically striate.

Length, 1.19 inch; height, 0.63 inch; breadth, about 0.32 inch.

Not having seen the hinge or the interior of this shell, we are left in doubt respecting its true relations, and merely place it provisionally in the above genus. Our specimens are all casts, but some of them retain traces of concentric lines, which appear to be the only kind of surface markings it had. Behind the beaks there is a narrow area or escutcheon, apparently formed by the thickening or inflection of the cardinal margin; this, however, may exist only on the internal cast.

Locality and position.—Near middle of the Jurassic beds, at the southwest base of the Black Hills. (Type No. 197.)

Thracia? arcuata.

(PLATE IV, Fig. 8.)

Thracia? arcuata, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 182; ib. Oct. 1860, 418.

Shell small, longitudinally subovate, more or less arcuate, moderately convex. Extremities rather narrowly rounded, and gaping a little. Cardinal margin sloping from the beaks; anterior slope more abrupt than the other. Beaks rather elevated, and unequal, that of the right valve being higher than the other, located in advance of the middle; posterior and anterior umbonal slopes prominent. Sides of the valves compressed or slightly concave in the central region, near the base. Surface of cast retaining small concentric marks of growth. (Hinge and interior unknown.)

Length, 0.62 inch; height, 0.34 inch; thickness, 0.23 inch.

This shell is more nearly related to the last than to any of the other species yet known from the rocks of the upper Missouri country, but differs in being more gibbous, and in having the valves more compressed or concave near the middle of the base, which imparts an arcuate outline to the ventral border. Its dorsal margin is also much less nearly horizontal, in consequence of the greater elevation of its beaks. Like the last, it has along the cardinal border of the internal cast, behind the beaks, a narrow circumscribed area or escutcheon, bounded by an obscure angle along each side. Knowing nothing of the nature of its hinge, or pallial line, we cannot determine its generic relations with much confidence.

Locality and position.—Same as last. (No. 211.)

Genus PHOLADOMYA, SOWERBY.

Synon.—*Pholadomya*, G. B. SOWERBY, Genera Shells, 1823, fasc. 19.—LATR. Fam. Nat. 1825.—DEFRANCE, Dict. Sci. Nat. t. XXXIX, 1826, 535.—J. SOWERBY, Min. Conch. 1827, tab. 545.—DESHAYES, Encyc. Meth. III, 1830,

tab. 1832; ib. 756; again in LAMK. 2d ed. VI, 63.—F. A. ROEMER, *Verst. Ool.* 1836, 126.—BRONN, *Leth.* 1837, 384.—AGASSIZ, *Etud. Crit. Mol. Foss.* 2d liv. 1842, 37.—HANLEY, *Ill. Cat.* 1844, I, 18, &c. &c.
Pholadomya, FLEMING, *Hist. Brit. An.* 1828, 408 and 424.
 ? *Cymella*, MEAK, *Smithsonian Chk. List Cret. Foss.* 1864, 34.
Etym.—*Pholas*; *Mya*.
Type.—*P. candida*, SOWERBY.

Shell thin, equivalve, pearly within; longitudinally oblong, oval, or subtrigonal; inequilateral and ventricose; extremities usually both gaping, but the posterior more widely than the other. Surface ornamented with radiating costæ, crossed by concentric striæ, or more or less distinct, sometimes nodular, ribs. Hinge with an obscure lamellar tooth, and a small triangular pit in each valve. Ligament short, external. Pallial line and muscular impressions generally faintly marked; the latter broadly sinuate.

The animal of *Pholadomya candida*, according to Owen, has its mantle provided with four openings—a pedal, a siphonal, and an anal aperture, with a fourth small circular orifice at the under part of the siphons. The gills are thick and finely plaited, the outer lamina being extended dorsally. The foot is provided with a small accessory bifurcating appendage behind.

Prof. Agassiz, who has produced the most important work on this genus, separates the species into two principal sections, and again divides each of these into several subordinate groups, as follows:—

SECTION I.—*Species Without a Circumscribed Cardinal Area.*

1. “*Multicostatæ*,” AGASSIZ.

Shell more or less elongated; radiating costæ numerous, well defined.

Examples.—*P. semicostata* and *P. multicostata*, AG. (*Jurassic and Cretaceous.*)

2. “*Trigonatæ*,” AGASSIZ.

Shell subtrigonal or more or less oblong; anterior side gibbous, often closed; posterior more compressed and distinctly gaping; beaks generally elevated, sometimes perforate. Surface with distinct concentric ridges, often extending upon the extremities of the valves, and crossed upon the flanks by well-defined tubercular radiating costæ; cardinal area distinct, but not sharply defined.

Examples.—*P. arcuata* and *P. nuda*, AG. (*Cretaceous, Tertiary, and Recent.*)

3. “*Bucardinae*,” AGASSIZ.

Shell subtrigonal, or more or less ovoid, gibbous, and comparatively thick; truncated, somewhat gaping, and usually flattened anteriorly; posterior side distinctly gaping; beaks gibbous and closely contiguous. Surface with strong, often tubercular radiating costæ on the flanks; muscular and pallial impressions distinct.

Examples.—*P. cincta* and *P. decussata*, AGASSIZ. (*Lias to Tertiary.*)

SECTION II.—*Species With a Circumscribed Cardinal Area.*

4. “*Flabellatæ*,” AGASSIZ.

Shell usually much elongated; radiating costæ prominent and often distant, generally confined to the flanks.

General aspect similar to the “*Multicostatæ*,” but differing in the possession of a defined cardinal area.

Examples.—*P. pelagica* and *P. similis*, AGASSIZ. (*Jurassic.*)

5. “*Ovales*,” AGASSIZ.

Shell ovoid, more or less compressed; one or the other of the extremities gaping; cardinal area sometimes not very distinct behind; costæ linear, often crenate.

Examples.—*P. tenuicostata* and *P. pectinata*, AGASSIZ. (*Jurassic.*)

6. “*Cardissoides*,” AGASSIZ.

Shell subtrigonal, similar to the “*Bucardinae*” of the first principal division, but differing in the possession of a defined cardinal area, and in having the costæ less numerous and more faintly marked.

Examples.—*P. cancellata* and *P. cardissoides*, AGASSIZ. (*Jurassic.*)

If we disregard the distinctions based upon the presence or absence of a circumscribed cardinal area (and there appear to be various intermediate gradations in this character), the foregoing six groups may probably be reduced to four, by uniting the "*Flabellate*" with the "*Multicostata*," and the "*Cardissoides*" with the "*Bucardina*." As thus arranged, these groups would apparently correspond nearly with what are usually regarded as subgenera, in conchology.

There is, however, another little group, differing, it is believed, from all of those defined by Prof. Agassiz, though probably nearest the "*Ovales*." It is only known in the Cretaceous rocks, and was called *Cymella* by the writer, in the Smithsonian Check List of North American Cretaceous Fossils, 1864, p. 34. The type is *Pholadomya undata*, Meek and Hayden; a small oval, subequilateral, rather compressed shell, with very regular concentric undulations (like those of *Inoceramus*), crossed by impressed radiating lines, only visible near the middle of the valves; cardinal area distinct.

Mr. Conrad has also proposed two subgenera under *Pholadomya*, viz., *Anatimya* and *Margaritaria*. The type of the first is his *Pholadomya anteradiata*, a Cretaceous species; and the other was found upon his *P. abrupta*, from the Miocene. We are not acquainted with these shells, but from the figures and descriptions, incline to the opinion that they should be regarded as the types of distinct genera, particularly the latter.

The genus *Pholadomya* was probably first introduced during the Liassic period, and attained its greatest development during the deposition of the later members of the Jurassic system. It was also well represented in the Cretaceous, and some two or three species have been described from the Tertiary rocks. A single species only (the type of the genus) is known to inhabit our existing seas. It is found on the shores of the island of Tortola, West Indies.

Some apparently closely allied forms are found in the Triassic, Permian, and Carboniferous rocks, but they all want the radiating costæ of the true *Pholadomyas*, and are referred to *Allorisma*, *Myacites*, *Platymya*, *Chænomya*, &c.

Pholadomya humilis.

(PLATE IV, Fig. 3, a, b.)

Pholadomya humilis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. May, 1860, 182; ib. Oct. 1860, 418.

Shell longitudinally oblong, ventricose. Posterior end rounded, and more or less gaping; base nearly straight along the middle; anterior end very short, narrowly rounded below the beaks. Dorsum nearly parallel with the base, slightly concave in outline; escutcheon lanceolate, and bounded by an obscure angle on each side. Beaks depressed, gibbous, incurved, and located in advance of the middle. Surface ornamented by small, regular, concentric wrinkles, crossed by a few raised lines, or small, distant costæ, which radiate from the back part of the beaks to the posterior and postero-basal margins.

Length, about 1.06 inch; height, 0.47 inch; breadth, 0.52 inch.

As far as can be determined from our imperfect specimens, this species seems to be new. It bears some resemblance in form to *P. subelongata*, Meek (Trans. Albany Institute, vol. IV, p. 42), from rocks of Cretaceous age on Vancouver's Island, but its beaks are more depressed, and its radiating costæ more distant, as well as more obscure.

Locality and position.—Lower part of the Jurassic beds at southwest base of Black Hills. (Type No. 217.)

CLASS **GASTEROPODA.**

SUBCLASS PULMONIFERA.

ORDER **Inoperculata.**

SUBORDER LIMNOPHILA.

FAMILY LIMNÆIDÆ.

Shell dextral or sinistral, thin, and horn-colored, varying from elongate-subcylindrical to ovate or discoidal; capable of receiving the entire animal when retracted; aperture simple; columella with or without a fold; lip sharp.

Animal with a short dilated muzzle; tentacles short and compressed, or elongate and slender, bearing the sessile eyes at their inner bases. Mantle with its margin simple or very rarely digitate. Mouth armed with a corneous upper mandible; lingual teeth numerous, arranged in transverse rows, the central minute and the lateral uncinat. Respiratory orifice on the right side, and the vent at the left of the neck. Foot ovate or lanceolate.

The above diagnosis is framed so as to include three subordinate groups, presenting in their various species a wide range of forms, and more or less important differences in the characters of the animal. These sections or subfamilies may be characterized as follows:—

1. Limnæinæ.

Shell spiral, dextral. Animal with tentacles short and flattened, or triangular. Includes *Limnæa*, and probably *Chilina* and *Amphipeplea*.

2. Physinæ.

Shell sinistral, otherwise much as in the *Limnæinæ*. Animal with tentacles elongate and slender. Includes *Physa*, *Physopsis*, *Aplexa*, *Macrophysa*,¹ and *Camptoceras*.

3. Planorbinaæ.

Shell involute, discoidal, dextral, or sinistral²? aperture more or less crescentic. Animal with tentacles as in the *Physinæ*. Includes *Planorbis*, *Taphius*, *Bathyomphalus*, *Gyraulus*, and *Segmentina*.

Notwithstanding the striking differences of form observed in the shells here ranged under the sections of this family, the animals of these several types agree in so many respects, that conchologists generally place them together in one family; while some also include *Ancylus*, *Acroloxus*, *Latia*, and *Gundlachia*.

¹ *Macrophysa*, Meek. The type for which this name is proposed is the curious Eocene species described by Deshayes (Coq. Foss. II, 90; X, 11 and 12) under the name *Physa columnaris*. It is a remarkably elongated, subcylindrical shell, with a deep suture, and a comparatively very small body whorl. Its aperture is oval and small, or less than one-third the entire length of the shell, angular behind, and subangular or abruptly rounded in front; columella smooth, flattened, and somewhat twisted. It seems to be intermediate between *Camptoceras* and *Aplexa*, and may possibly be ranged as a subgenus under the latter.

² See note, p. 106.

14 December, 1864.

In their habits, these mollusks all agree in being inhabitants of fresh water. They are true air-breathers, being compelled to come to the surface occasionally for that purpose. They are widely distributed in almost all parts of the world where ponds, streams, and other bodies of fresh water exist, and feed upon confervæ and other aquatic vegetation.

SUBFAMILY PLANORBINÆ (p. 104).

Genus PLANORBIS, MÜLLER.

- Synon.*—*Planorbis* (part), MÜLLER, Verm. Terest. et Fluv. 1774, 152; Zool. Dan. 1776, 238.—BRUG. Encyc. 1789, I, xvi.—CUVIER, Tab. Elem. 1798 (not *Planorbis*, LAMARCK, Prodr. 1799, 76; nor 1801, Syst. An. 93).
Orbis, SCHROT. Jour. F. d. L. d. III, 1776, 10 (not LEA, 1833).
Vortex, HUMPHREY, Mus. Col. 1797 (58, sec. ed.).
Anisus, FITZ. VERZ. 1833, 111.
? Bathyomphalus, AGASSIZ, Catal. 1837, 20.
Helisoma, SWAINSON, Malac. 1840, 337.
Spirorbis, SWAINSON, ib. (not LAMARCK, 1815).
Planorbina, HALDEMAN, Fresh-water Univ. U. S. 1842, 14.
Planorbella, HALDEMAN, ib. 1842.
? Gyraulus, AGASSIZ, Nouv. Mém. Soc. Helv. I, 1837.
Planodiscus, STEIN, * * * 1843.
? Taphius, H. & A. ADAMS, Genera Recent Mol. II, 1856, 264.
Menetus, H. & A. ADAMS, ib.
Etym.—*Planus*, flat; *orbis*, an orb.
Type.—*Helix cornea*, LINNÆUS.

Shell dextral, or sinistral?¹ discoidal or subdiscoidal, the whorls being nearly or quite on the same plane; right side generally flat, or sometimes either a little elevated or concave; left side more or less excavated; volutions rounded, compressed, or angular; aperture crescentic or suboval, sometimes dilated; peristome thin, incomplete, right margin projecting.

The typical forms of this genus have the shell much depressed, and the volutions numerous, rounded or without angles, and visible on both sides; while the mouth is not dilated. As above defined, however, it is made also to include several subordinate groups which depart more or less from the typical species, though generally placed here by conchologists. Some of these types should probably stand as distinct genera, but as it is scarcely practicable, in Palæontology at least, always to distinguish between them, we have preferred to define the genus in its widest sense. The subordinate groups, however, not agreeing exactly with the typical forms, may be characterized as follows:—

1. *Planorbella*, HALDEMAN.

Shell with few whorls, which are usually angular on the left side; aperture distinctly expanded, or bell-shaped.

Type.—*Planorbis campanulatus*, SAY.

¹ Conchologists generally regard these depressed shells as being dextral; but O. A. L. Mörch offers some apparently good reasons for viewing them as properly sinistral forms (Conch. Jour. xi., 2d Ser. 235). This conclusion seems to be sustained by the form of the young of some American species, one of which was described by DeKay as a truncated *Physa*. On the other hand, however, monstrosities of some foreign species with an elevated spire, are generally dextral.

2. Helisoma, SWAINSON.

Shell ventricose, concave on both sides; volutions few, generally angular on one or both sides, broadly rounded on the periphery.

Type.—*P. bicarinatus*, SAY.

3. Taphius, H. & A. ADAMS.

Shell ventricose, somewhat irregular; whorls rounded on the outer side, prominent or subangular around the rather small, deeply excavated umbilical cavity of the left side. Aperture large, obovate, straight within.

Type.—*P. andecolus*, D'ORBIGNY.

4. Menetus, H. & A. ADAMS.

Shell depressed, volutions increasing rapidly in size; aperture suboval; periphery more or less angular.

Example.—*P. angulatus*, PHIL.

5. Anisus, FITZINGER.

Shell strongly depressed; volutions very numerous; periphery angular.

Example.—*P. carinatus*, MÜLLER.

6. Bathyomphalus, AGASSIZ. (= Spirorbis, SWAINSON, not LAMK.)

Shell discoid, rounded on the periphery; whorls numerous, closely embracing on the left side, exposed on the right; aperture narrow, crescentic; umbilical cavity on the left side narrow and profound.

Type.—*Helix contorta*, LINNÆUS.

7. Gyraulus, AGASSIZ. (= Nautilina, STEIN.)

Shell discoid, slightly convex on the right side, flat or broadly concave on the left; volutions few, rapidly increasing in size, obliquely depressed, but not angular.

Example.—*P. albus*, MÜLLER.

So far as at present known, the genus *Planorbis* seems to have been first introduced during the Liassic epoch; it is also known to have been represented during the deposition of the Wealden formation. Many species have likewise been found in the fresh-water Tertiary deposits of various countries, though the genus seems to attain its greatest development at the present time, and is widely distributed, particularly in northern temperate regions.

Planorbis veterius.

(PLATE IV, Fig. 1 and 1a, b.)

Planorbis veterius, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Oct. 1860, 418.

Shell small, planorbicular; right side distinctly concave. Volutions three and a half to four, more or less rounded, increasing rather rapidly in size; slightly concave on the inner side for the reception of each succeeding whorl, and prominent or subangular a little within the middle on the upper side; most convex outside of the middle below. Concavity of left side rather large, basin-shaped, and, like that on the right, showing all the whorls. Aperture oblique, a little oval. Surface nearly or quite smooth.

Greatest diameter, 0.15 inch; do. of outer whorl, 0.05 inch.

Locality and position.—Southwest base of the Black Hills, associated with *Unio nivalis*, *Viviparus Gilli*, and *Valvata? scabrida*; also, apparently, with *Ammonites Henryi*. As these fresh-water shells were found in loose fragments, we are not sure they hold the same position as the Ammonite, though they were picked up at the base of an outcrop of hard bluish-gray limestone, in masses agreeing in their lithological characters with the bed containing the Ammonite. They may possibly be Tertiary species, but differ from all those we have seen from rocks of that age in the Northwest. It is only provisionally we place them along with the Jurassic forms. (Type No. 317.)

SUBCLASS PROSOBRANCHIATA.

ORDER **Rhipidoglossata.**

SUBORDER PODOPTHALMA.

FAMILY NERITIDÆ.

Shell generally thick, varying from subovate or ovate-subglobose, to depressed hemispherical, not umbilicate; spire very small or sometimes nearly obsolete, often lateral, simple within, from the absorption of the inner whorls; body volution very large; aperture semilunar, not pearly within.

Operculum wholly, or in part shelly, subspiral, articulated with the inner lip by one or two processes.

Animal without lobes or neck lapets; muzzle broad, short, and more or less emarginate; tentacles long, subulate, and having the eyes on peduncles at their outer posterior bases. Foot oblong-subtrigonal; margins simple, not provided with filaments or membrane. Dentition much as in the *Trochidæ* ($\times .3$, 1, $3.\times$), the rachidian tooth being very small, laterals unequal, and the uncini numerous, with the first one large, and the others very small, slender, and hooked.

This family embraces a large number of species, which have been variously grouped into genera and subgenera by different authors. The groups most usually adopted for the reception of the recent species are *Nerita*, *Neritella*, *Clithon*, *Alina*, *Neripteron*, and *Catillus*. The extinct genera known at this time are *Neridomus*, *Velates*, *Deshayesia*, *Neritoma*, and *Pileolus*. There are, however, probably several undescribed genera amongst the fossil species referred to *Nerita*; and some of the Carboniferous shells referred to McCoy's genus *Naticopsis* (though not the typical species) seem to belong to some genus of this family rather than to the *Naticidæ*.

Genus NERITELLA, HUMPHREY.

Synon.—*Neritella*, HUMPHREY, Mus. Col. 1797, 57.—GRAY, Zool. Proc. 1847, 148.—H. & A. ADAMS, Genera Recent Mol. I, 1854, 380.

Neritina, LAMK. Phil. Zool. 1809; Hist. VI, 1822, 182.—BRONN, Leth. 1837, 390.—PUSCH, Pol. Palæont. 1837, 97.—SWAINSON, Malacol. 1840, 347.—RECLUZ, Revue Zool. 1841, 273, &c.

Theodoxus, MONTFORT, Conch. Syst. II, 1810, 351.

Lamprostoma, RAFINESQUE, Anal. Nat. 1815 (not SWAINSON, 1840)

Nereina, DE CRIST. and JAN. Cat. 1832.

Clypeolum, RECLUZ, Revue Zool. 1842, 234.

Puperita, GRAY, Guide to the Syst. Dist. Mol. 1857, 137.

Etym.—*Nerita* dimin.

Type.—*Nerita viridis*, LIN.

Shell ovate, or rhombic subglobose, rather thin, covered with a corneous epidermis; surface smooth or striate, and often ornamented with beautiful and vivid colors. Spire short, more or less conoid. Aperture semilunar; inner lip and columella straight and flattened or septiform, with a smooth or crenulated margin.

Operculum thin, testaceous, with a corneous margin; outer surface smooth; provided with two apophyses; the upper shorter, sometimes dilated and crested, the lateral arcuate.

The *Neritellas* mainly inhabit fresh water, but they are often found in brackish, and sometimes even in salt-water. Others are amphibious, and crawl out upon the roots and trunks of trees along the margins of streams, ponds, and other bodies of water. The genus embraces a considerable number of species which are widely distributed, almost exclusively in tropical and torrid regions.

Conchologists differ in regard to the limits of this group, some including in it, as sections or subgenera, *Dostia*, *Alina*, *Neripteron*, and *Clithon*; while others regard not only these, but some of the others we have here included in the list of synonyms, as so many distinct genera.

The typical *Neritellas* differ from the closely allied groups *Dostia*, *Alina*, and *Neripteron*, in being more symmetrical, less depressed shells, with a more developed and less eccentric spire, as well as a greatly less expanded aperture, and a less developed lip.

From *Clithon*, with which they agree more nearly in form, they differ in never being spinous, and always without a tooth near the upper part of the columella. From the genus *Nerita* these shells may be distinguished by their much thinner and smoother shells, and smooth or less strongly dentate columella, as well as by the exclusively marine habits of the former.

It is difficult to arrive at a satisfactory conclusion in regard to the geological range of this genus until the affinities of a number of fossil species have been more accurately determined. It seems, however, to be an older type than *Nerita*; indeed, as already intimated, even some Carboniferous forms usually placed in the genus *Naticopsis*, are very closely similar to *Neritella*, though doubtless generically distinct. Some of the so-called *Neritas* from European Jurassic beds probably belong to this genus, though most of them present differences that place them either in the genus *Neridomus*, or apparently in allied, but undefined genera. If we are right in referring the bed from which the following described species was obtained, to the horizon of the Jura, it would establish the existence of the genus during that epoch beyond doubt, since it is a typical *Neritella*.

A few of the Cretaceous *Neritas*, so-called, seem also to belong here, and the genus was well represented during the tertiary epoch. It attains its maximum development, however, at the present time.

Neritella Nebrascensis.

Neritella Nebrascensis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1861, 444.



Neritella Nebrascensis.



Neritella Nebrascensis.
Enlargement of bands of color.

Shell small, obliquely rhombic-oval; volutions three to three and a half, convex, increasing rapidly in size, the last one composing more than nine-tenths of the entire shell; suture well defined. Aperture broad ovate. Colu-

mella moderately thickened and flattened, its margin a little arched and smooth; usually having a slight umbilical groove along the anterior outer margin of the inner lip. Surface smooth, or only having obscure lines of growth; ornamented with alternate dark and light-colored zigzag bands crossing the whorls at right angles to the suture.

Height, 0.40 inch; greatest transverse diameter, measuring from the outer side of the aperture obliquely upwards to the most prominent part of the body whorl on the opposite side, 0.44 inch; height of the aperture, 0.35 inch; breadth of do., 0.25 inch.

This must have been a very pretty little shell before its bands of color were partly obliterated by the fossilizing process. A few of the specimens, however, still retain these colored markings so as to be quite distinctly seen when moistened. We know of no fossil species with which it is liable to be confounded. Amongst recent species, it is perhaps most nearly represented by the European *N. rivalis*, Parreyss, which is of about the same size, and has much the same form and style of coloring, though its aperture is rather less expanded, and its inner lip a little wider; while its bands of color are narrower, and not so abruptly nor so frequently deflected.

This species belongs to the subordinate group *Neritina*, as defined by H. & A. Adams, and Chenu.

Locality and position.—Head of Wind River, Dakota Territory, where it occurs associated with *Lioplacodes veternus*, M. & H., in beds supposed to be of Jurassic age. (Type No. 1979.)

ORDER Cyclobranchiata.

? FAMILY DENTALIIDÆ.

Shell tubular, slightly arched, truncated and open at both ends; aperture at the smaller end sometimes with a slit or fissure on the dorsal side.

Operculum wanting.

Animal with lingual membrane comparatively broad; teeth in three series, the middle denticulate, and the laterals broad and simple. Head rudimentary, being without eyes or tentacles; mouth with cirrhatel lips. Mantle circular, thick and fleshy in front, and covering the forepart of the body. Gills two, symmetrical, and placed behind the heart. Foot conical, small, or rudimentary, with two symmetrical side-lobes, and an attenuated hollow base connecting with the stomach, which is provided with a strong internal "gizzard."

Although these curious mollusks are known to possess red blood like the earthworms, the rudimentary condition of their eyeless head, without traces of tentacles, the position of their symmetrical gills, and the union of the sexes in each individual, are characters showing their low rank amongst the *Gasteropoda*. They are generally placed with the *Prosobranchiata*, though, as has been suggested by several conchologists, they might with almost equal propriety be ranged with the *Opisthobranchiata*.

This family includes only the genera *Dentalium*, *Entalis*, and *Helonyx*.

Genus DENTALIUM, LIN.

Synon.—*Tubulus*, *Dentale*, *Dentalites*, *Syringites*, &c., of ante-Linnæan authors.

Dentalium, LINNÆUS, Syst. Nat. 1740, sec. ed. 64; ib. sixth ed. 1748, 75; ib. tenth ed. 1758, 785; ib. twelfth ed. 1768, 1263.—LAMK. Prodr. 1799, 78; Syst. An. 1801, 326; Hist. Nat. V, 1818, 341.—SCHUM. Ess. 1817, 263.—BLAINV. and DEFR. Dict. Sci. Nat. XIII, 1819, 69, &c.

Etym.—*Dens*, a tooth.

Examp.—*Dentalium elephantinum*, LIN.

Shell elongate, terete or angular, smooth, costate or striate; aperture circular; lip simple, entire; margin of the posterior opening without a fissure.

The shells of this genus are very similar to those of the allied group *Entalis*, but the latter differ in having a slit or fissure in the dorsal side at the smaller extremity. The genus *Ditrupa*, one of the marine worms, also secretes a shelly tube, sometimes resembling that of *Dentalium*, though it can generally be distinguished from the latter by having its sides more or less ventricose near the aperture, while the shell of *Dentalium* is gradually and regularly tapering from the larger to the smaller extremity.

The genus *Dentalium* seems to have made its first appearance during the Devonian epoch. It is also known to occur in the Carboniferous rocks, and ranges through all the succeeding formations. It is well represented in the existing seas, and probably attains its maximum development at the present time. The recent species are usually found in deep seas, where they are said to feed upon *Foraminifera* and small bivalves.

Dentalium subquadratum.

Dentalium? *subquadratum*, MEEK, Proceed. Acad. Nat. Sci. July, 1860, 311.

Shell small, thin, regularly and slightly arcuate, very gradually tapering, flattened on four sides so as to present a subquadrangular section, the angles being a little rounded; section of internal cavity circular; surface apparently without longitudinal or transverse striæ.

Length, about 1 inch; diameter of larger end, 0.05 inch; do. of smaller end, 0.02 inch.

This species is remarkable for its quadrangular form, which gives rise to some doubts whether or not it is a true *Dentalium*; though we know of no other genus to which it can be referred.

Locality and position.—North Platte River, at the Red Buttes, Lat. 42° 50' north, Long. 106° 40' west. (Type, No. 677.)



Dentalium
subquadratum.

ORDER **Ctenobranchiata** (= *Pectinibranchiata*).

SUBORDER ROSTRIFERA.

FAMILY VALVATIDÆ.

Shell small, turbinate or discoidal, provided with an epidermis; aperture with an entire peritreme; last volution sometimes free at the aperture. Operculum corneous, circular, multispiral, the whorls being provided with a thin elevated margin.

Animal with muzzle produced; tentacles cylindrical; eyes at their outer

bases. Mantle simple in front; branchial plume pectinated, partially exposed on the right side when the animal walks; the laminae pinnate, spirally twisted, protected by a respiratory lobe. Foot bifid anteriorly. Lingual teeth (3. 1. 3) hooked and denticulate, the central series broad, lateral lanceolate.

This family embraces but the typical genus *Valvata*, and *Lyogyrus*. The species are rather widely distributed in temperate regions, and inhabit lakes, ponds, ditches, and sluggish streams. They are the only known Prosobranchiate Gasteropods having exposed gills.

Genus VALVATA, MÜLLER.

Synon.—*Valvata*, MÜLLER, Hist. Verm. II, 1774, 198; and Zool. Dan. Prodr. 1776, 239; STUDER, COXE Trav. III, 391; ABILDGAARD, Skrivt. af Naturh.—SELSK. 1794, III, 61; DRAPARN. Tabl. 1801, 30; and Hist. 1805, 26, 28, 41; LAMK. Extr. d'nn Conrs. 1812, and Hist. VI, 1822, II, 171.

Valvearius, DUM. Zool. Anal. 1806, 164.

Gyrorbis, FITZINGER, Verz. 1833, 117.

Planella, SCHLÜT, Vz. 1838, 13.

Valvata, BERGE, Conch. Buch, 1847, 17, 20, 26.

Tropidina, H. & A. ADAMS, Genera Recent Mol. 1856, 344.

Etym.—*Valvatus*, having folds or valves.

Type.—*Valvata cristata*, MÜLLER.

Shell umbilicate; spire usually much depressed, sometimes moderately prominent; whorls rounded or carinate; epidermis corneous; aperture circular; lip thin and sharp.

The shells of this genus are distinguished from those of the allied type *Lyogyrus* by never having the last turn free at the aperture. The group embraces two rather marked sections, as follows:—

1. *Valvata* (proper) = *Gyrorbis*, FITZINGER, = *Planella*, SCHLÜT.

Shell greatly depressed or planorbiclar; with a very wide umbilicus and rounded whorls.

Example.—*V. cristata*, MÜLLER.

2. *Tropidina*, H. & A. ADAMS.

Shell turbinate, or having the spire more or less prominent, and the volutions either carinate or rounded.

Examples.—*V. tricarinata*, SAY, and *V. piscinalis*, MÜLLER.

As there are some slight differences in the details of the lingual teeth in these two groups, as well as in the form of the shell, it is possible they may more properly constitute distinct genera.

The Messrs. H. & A. Adams admit three subgenera under this genus, in their valuable work on the genera of Recent Mollusca. Regarding such forms as *V. piscinalis* as typical, they adopt Fitzinger's name *Gyrorbis*, for such types as *V. cristata*, Müller, and propose the name *Tropidina* for forms like *V. tricarinata*, Say. As the genus *Valvata*, however, was originally founded by Müller, upon *V. cristata*, that species must be regarded as the type, and as *Gyrorbis* was also founded upon the same shell it must be viewed as exactly synonymous with *Valvata* proper, and cannot be used for another group. Although *Tropidina* was proposed for the reception of carinated forms only, there is no reason why it should not also include the other turbinate species, with rounded whorls, and a more or less prominent spire, since the carinated character is not constant even in the species *tricarinata*.

If the following described species really belongs to this genus, it would seem to establish the existence of the group during the deposition of the middle or older members of the Jurassic system. This conclusion, however, should not be adopted until all doubts are removed in regard to its generic characters, and exact stratigraphical position. The existence of this genus during the Wealden period is, however, well established. It is also well represented in the fresh-water Tertiary deposits of Europe and occurs in the Tertiary beds of the central districts of North America, and probably attains its greatest development at the present time.

Subgenus TROPIDINA, H. & A. ADAMS (p. 112).

Valvata? scabrida.

(PLATE IV, Fig. 2, a, b.)

Valvata? scabrida, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Oct. 1860, 418.

Shell small, subglobose, thin; spire rather depressed. Volutions three to three and a half, increasing rapidly in size, very convex; subangular around the upper outer side, and horizontally flattened between the angle and the suture; ventricose on the outer and under sides. Suture well defined; aperture round, oval? Surface ornamented by strong, regular marks of growth.

Length and breadth, each about 0.16 inch.

Not having seen specimens of this little shell sufficiently detached from the very hard, brittle, argillo-calcareous matrix, to show very satisfactorily the form of its aperture, we are left in some doubt respecting its generic relations. From its general appearance, however, taken in connection with the fact that a few other fresh-water shells occur in the same bed, we are led to regard it as most probably a *Valvata*, though it may possibly be a *Viviparus*, or belong to some marine genus. Its principal distinguishing characters are the small number and ventricose form of its whorls, and strongly defined marks of growth.

Locality and position.—Near southwest base Black Hills, where it was found in loose fragments of a hard bluish-gray argillo-calcareous rock, associated with *Planorbis veternus* and *Unio nucalis*. These masses were found at the base of an outcrop of very similar rock, containing *Ammonites Henryi*, and seem to belong to the same formation. The fresh-water species may be Tertiary, though we think they and the *Ammonite*, with which they appear to be associated, are probably of Jurassic ages. (Type, 316.)

FAMILY VIVIPARIDÆ.

Shell varying from subglobose to turbate, or conical subovate; rather thin, or more or less thickened, covered with an epidermis; surface smooth, spirally striate, or with revolving, rarely nodose, carinæ; aperture oval or subcircular, simple, and rounded anteriorly; peritreme continuous, simple.

Operculum annular, or rarely with a subspiral nucleus.

Animal retractile within the shell; foot moderate, and adapted for crawling only; rostrum moderate, nearly or quite entire at the extremity; tentacles tapering, retractile, and having the eyes on short tubercular

prominences at their outer bases. Gills internal, comb-like, single. Tongue short; lingual teeth in seven longitudinal rows (3. 1. 3), lateral, more or less curved, truncated and serrate, or pointed and claw-shaped at the extremity. Generative organs unisexual; in the male, included in the right tentacle; in the female, under the margin of the mantle on the same side. Female ovo-viviparous.

The following groups are included in this family, viz.: *Viviparus*, *Tulotoma*, *Campeloma* (or *Melantho* of authors; not Bowdich), *Lioplax*, and *Lioplacodes*. The groups *Larina*, *Paludomus*, *Bithynia*, *Bithynella*, *Ganga*, *Tanalia*, *Philopotamis*, and *Rivulina* have also been placed here by some authors, but the labors of Prof. Gill and Dr. Stimpson have shown that all these should be eliminated, thus leaving the *Viviparidæ* probably a strictly ovo-viviparous group.

GENUS VIVIPARUS, MONTFORT.

Synon.—*Vivipare*, LAMARCK, Phil. Zool. 1809, ii. 320 (without example, diagnosis, or figure); and again, in the same way, Extr. d'un Cours. 1812.

Viviparus, MONTFORT, Syst. 1810, ii. 247.—GRAY (in part), Proceed. Zool. Soc. 1847, part xv. 155; and again, Guide to Syst. Distr. Moll. Brit. Mus. 1857, i. 112; GILL, Proc. Acad. Nat. Sci. Phila. 1863, 37.

Henterum, HUBN. Epist. I. 1810.

Paludina, LAMARCK, Extr. d'un cours. 1812 * * *; and Hist. 1822, vi. 172.—SCHWEIGER. (part) Naturg. 1820, 736.—BLAINVILLE (part), Diet. Sci. Nat. 1824, xxxii. 320; and 1825, xxxvii. 300.—DESHAYES (part), Encyc. Meth. 1832, iii. 689, and of various later authors.

Vivipara, SOWERBY, Mineral Conchology, 1813, tab. 31.—H. & A. ADAMS (part), Genera Recent Moll. 1854, i. 38.

Etym.—*Vivus*, alive; *pario*, to bear or bring forth young.

Type.—*Helix vivipara*, LINN.

Shell ovate or conic-subovate, thin, usually with a small umbilical perforation; volutions rounded or more or less flattened; surface smooth or with revolving lines or carinæ; epidermis olivaceous, often with revolving bands of color; aperture more or less regularly ovate; outer lip thin, straight in outline, and continuous on a plane with the inner.

Operculum corneous, entirely annular.

Animal with lateral teeth of the lingual ribbon oblong, arched, somewhat pointed below, truncated and serrate above; median tooth shorter, curved, more or less rounded, and serrate above; the middle denticle being larger than the others.

These mollusks inhabit rivers, lakes, and other bodies of fresh water, and are widely distributed in the Northern hemisphere. This genus is related to *Campeloma*, *Lioplax*, and *Tulotoma*, which have, indeed, until recently, been included in it, either as subgenera or otherwise, by most authors. It may be distinguished from the former two groups, however, by its thinner shell, and by its outer lip being straight in outline and continuous on a plane with the inner, instead of being inversely sigmoid. A more important difference, however, is in the lingual teeth, which, in *Campeloma* and *Lioplax*, have the upper margins smooth, or only very minutely serrated, while the outer two on each side are pointed and claw-shaped, instead of truncated above. *Lioplax* is also distinguished by a subspiral opercular nucleus.

From *Tulotoma* these shells are distinguished by being thinner and not nodular; while the animal of the latter genus is said to have more the habits of *Anculosa*, being found clinging to stones in running water instead of crawling upon the muddy bottoms of sluggish streams and lakes.

This genus is believed to date back as far as the Jurassic epoch. It also occurs in the Wealden deposits, and was well represented during the deposition of all the members of the Tertiary system, at which time the species seem to have been quite as numerous as at present, if not even more so. We already know some six or seven species from the Lignite Tertiary beds of the Upper Missouri and Rocky Mountain regions.

Viviparus Gilli.

(PLATE V, Fig. 3, a, b.)

Shell small, ovate-subglobose; volutions about four and a half, increasing rather rapidly in size, ventricose, rounded, last one larger than all the others; suture deep and well defined, in consequence of the convexity of the whorls; umbilical chink very small or closed; aperture oval, slightly oblique, and nearly equally rounded above and below, there being but a very slight angularity at the inner side above; peritreme distinctly continuous in adult shells; surface only marked by small, rather obscure lines of growth.

Length of the largest specimen seen, 0.47 inch; breadth, 0.42 inch.

This seems to be a rather rare species, only three specimens having been found, and none of these are entire. It is most nearly allied to the common recent American species *Viviparus lineatus*, Valenc., but is much smaller, and differs in having its aperture more nearly equally rounded above and below. There can be no question about its being a typical *Viviparus*.

We take pleasure in dedicating this oldest known American species to our friend Prof. Theo. Gill, of Washington City, who first pointed out the true distinguishing characters between this and the allied group *Campeloma*, Raf. (= *Melantho* of authors).

Locality and position.—Same as last, where it occurs associated with *Neritella nebrascensis* and *Lioplacodes veteris*. (Type No. 4035.)

Genus LIOPLACODES, MEEK.

Synon.—*Melania* (sp.), MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1861, p. 444.

Lioplacodes, MEEK, Smithsonian Check List, Jurassic fossils, 1864, 29 and 40.

Etym.—*Lioplax*.

Type.—*Melania* (*Potadoma*) *veteris*, MEEK & HAYDEN.

Shell conoid-subovate, rather thick, scarcely perforate; spire prominent; aperture obliquely subovate, rather obtusely angular behind, and somewhat narrowly rounded and faintly sinuous in front; peritreme continuous; outer lip inversely sigmoid; surface with revolving lines.

Animal and operculum unknown.

The shell for the reception of which this genus has been proposed is one of those forms presenting an intermediate appearance between the *Melaniidæ* and *Viviparidæ*, so perplexing where we can know nothing in regard to the nature of the animal or operculum. Its comparatively slender subconical form, and the slight flattening

of the upper oblique slope of the whorls, together with its revolving lines, give it much the appearance of some types of the *Melaniidæ*; while its small but unmistakable umbilical pit, and continuous peritreme, together with the expression of the aperture, indicate nearer affinities to the *Viviparidæ*. It is perhaps most nearly allied to the genus *Lioplax* of Troschel, but differs from the type of that genus (*Paludina subcarinata*, Say) in having a much less ventricose and proportionally smaller body whorl, more attenuate spire, and numerous thread-like revolving lines, instead of a single carina; while the posterior extremity of its aperture is subangular instead of rounded, in consequence of the oblique flattening of the upper part of the body volution.

***Lioplacodes veternus*.**

Melania (Potadoma) veterna, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. Dec. 1861, p. 444.

Lioplacodes veternus, MEEK, Smithsonian Check List, Jurassic fossils, 1864, 29.

Shell with spire elevated; volutions about six, very convex, rounded at the middle, and often obliquely a little flattened above; suture deep; aperture obliquely oval, subangular behind, and rather narrowly rounded and faintly sinuous in front, much more prominent or convex on the outer than the inner side; inner lip disconnected from the columella, so as to leave a small umbilical chink; outer lip broadly sinuous in outline near the middle of the aperture or slightly above, and most prominent below. Surface marked by strong flexuous striæ of growth, which are crossed by more or less distinct thread-like revolving lines, some four or five of which, near the middle of the body whorl, are larger and more widely separated than those below.



Lioplacodes veternus.

Length, 0.77 inch; breadth, 0.50 inch; apical angle convex, divergence about 47°.

This interesting species was at first placed by us, with considerable doubt, in the genus *Melania*, as that group was then understood by most conchologists. The necessity for restricting that name, however, to such forms as *M. amarula*, has become more apparent from late investigations, while the various recent American species resembling our shell have been distributed into several genera. In endeavoring to determine to which of these our species is most nearly allied, by clearing away the matrix with care from about the aperture, it has been found, quite unexpectedly, to present characters, as already stated, showing affinities to the *Viviparidæ*, rather than to the *Melaniidæ*. And yet it differs from the known genera of that family to such an extent that it has been thought desirable to regard it as the type of a new genus.

Locality and position.—Head of Wind River, Dakota Territory, from beds referred provisionally to the Jurassic system. Associated with *Neritella Nebrascensis*. (No. 1978.)

CLASS CEPHALOPODA.

ORDER Tetrabranchiata.

FAMILY AMMONITIDÆ.

Shell involute, spiral, variously curved, or straight; outer or last chamber large. Aperture varying in form with the genera and species; lip often more or less produced on the outer or dorsal side, sometimes hooded,

or provided with lateral appendages. Septa more or less deeply lobed on the margins; presenting a convex outline (in their mesial section) on the side facing the aperture; lobes variously plicated or sinuous and dentate or merely serrated on the margins. Siphon dorsal, with relation to the shell, cylindrical, slender, never occupied by an internal organic deposit, piercing the septa from within outwards, or towards the aperture; envelop solid and persistent.

Animal unknown, all the genera of the entire group being extinct.

This family is nearly related to the *Goniatitidæ*, through the intermediate *Ceratites*. Indeed, previous to the researches of the distinguished palæontologist Barrande, the *Goniatites* were by most authors, along with the *Ceratites*, included in the family *Ammonitidæ*; and some even included these three genera under the single generic name *Ammonites*. M. Barrande, however, has shown (Bul. Geol. Soc. Fr. 2, ser. t. xiii, p. 375, 1856) that the *Goniatite* group differs from the true *Ammonitidæ*, not only in the greater simplicity of their septa, but also in having the neck or gullet of the siphon always projecting backwards, as in the *Nautilidæ*, instead of forwards, or towards the aperture, as in the *Ammonitidæ*. Again, he finds that a mesial section of their septa shows a concave, instead of a convex, outline on the side facing the aperture; while their siphonal envelop is not solid and persistent, as is usually the case with *Ammonitidæ*.

From these facts some authors have gone to the opposite extreme, and included the *Goniatite* group in the *Nautilidæ*. M. Barrande, however, has shown, in the paper above cited, that at the same time that they agree with the latter family in these several characters, they still differ in some important elements of structure. In the first place, they always differ in having the septa provided with a dorsal lobe, and generally in having their septa more lobed or sinuous on the sides. Another important difference is the entire absence of the peculiar organic deposit within the siphon, such as we sometimes see in extinct forms of the *Nautilidæ*. Again, they differ in having the siphon invariably on the outer side, instead of varying in its position between the dorsal and ventral margins. Hence we are inclined to agree with M. Barrande in separating these cephalopods into the three distinct families, *Nautilidæ*, *Goniatitidæ*, and *Ammonitidæ*.

It is an interesting fact that, even after excluding the *Goniatite* group from the family *Ammonitidæ*, we still have a very extensive and varied group of shells, amongst which we observe a representative, so far as form is concerned, of nearly every genus, not only of the *Nautilidæ*, but also of the apparently distinct *Orthoceras* group. This fact would seem to argue, either that the *Nautilus* and *Orthoceras* groups should not be separated, or that there may be genera belonging to more than one family included in the *Ammonitidæ*, even as here defined. Still, notwithstanding the great differences of form observed amongst these fossils, they agree so very nearly in their internal structure, that it seems difficult, in the present state of our knowledge, to point out constant characters by which they can be divided into distinct families, or even well-defined subfamilies.

When we take into consideration the infinite diversity of beautiful forms pre-

sented by the shells of these mollusks, their great numbers, and often elaborately ornamented surface, and remember the large sizes to which they sometimes attained, it is easy to understand that they must have constituted a marked and peculiar feature of the molluscan fauna of the Jurassic and Cretaceous seas.

It not unfrequently happens, where the substance of the shell is well preserved, that in breaking specimens from the rocky matrix in which they are enveloped, the outer porcellaneous layer exfoliates, leaving the elegantly sculptured surface of the fossil covered with the brilliantly iridescent inner pearly layer, in which condition they form exceedingly beautiful cabinet specimens. It is necessary, however, to remove this inner layer also, when we wish to study the complex internal structure of the shell, which furnishes important characters for the distinction of species and sometimes of genera.

The following are the genera we would at present include in this family, viz: *Baculina*, *Baculites*, *Ptychoceras*, *Hamulina*, *Hamites*, *Toxoceras*, *Crioceras*, *Ancyloceras*,¹ *Scaphites*, *Ceratites*, *Ammonites*, *Anisoceras*, *Helicoceras*, *Heteroceras*, and *Turrilites*. It seems to be impossible, however, by a linear arrangement, to place these groups so as always to bring together those most nearly allied.

REMARKS ON THE SO-CALLED GENUS TRIGONELLITES, OF PARKINSON, 1811.

Aptychus, MEYER, 1831.—*Ichthyosygon*, BOURDET, 1822.—*Munsteria*, DESLONGCHAMPS, 1835.

A consideration of the family *Ammonitidæ* would scarcely be complete without some allusion to those curious bodies generally known by the names *Trigonellites*, *Aptychus*, &c., so often found within, or associated with, the shells of the typical genus. Few objects amongst all the relics of extinct life have been more puzzling to the palæontologist, or given rise to a greater diversity of opinions than these. Most of the early palæontologists regarded them as the shells of bivalve mollusks, as did Parkinson, Deslongchamps, and some later investigators; while others supposed them to be the palatal bones of fishes. Others, again, maintained that they are the internal osselets of some extinct cephalopod allied to *Teudopsis*; and still others, that they are an internal organ of *Ammonites*, analogous to that connected with the digestive apparatus of *Bulla* and some other *Gasteropoda*. Burmeister supposed them to be external supplementary shell pieces of *Ammonites*, designed for the protection of the branchial sack when the animal was partly protruded from the shell. More recently, D'Orbigny, Pictet, and some others have advocated, with much ingenuity, an opinion first suggested by Scheuchzer, that they are the valves of pedunculated Cirripedes allied to *Anatifa*.

The impression, however, has for some time been gaining ground amongst palæontologists that these bodies really are organs or appendages of the Cephalopods, with the shells of which they are so frequently found associated. And since Darwin

¹ It is possible the genus *Ancyloceras* may be synonyms with *Crioceras*, since the species for which the latter genus was proposed have never, we believe, been found entire; and it yet remains to be clearly demonstrated that *Ancyloceras* was not founded upon perfect specimens of the same type. If so, the name *Crioceras* will take precedence, because it was published in 1836, and *Ancyloceras* in 1842.

has shown that it is against all analogy to regard them as the valves of Cirripedes,¹ the most generally received opinion is that they are the opercula of Ammonites, Scaphites, Goniatites, &c.² This opinion would also seem to receive considerable weight from the discovery, in few rare instances, of an Ammonite with a Trigonellite closing and apparently exactly fitting its aperture.³

Before bringing forward some reasons, however, for doubting the correctness of this conclusion, suggested by a remarkable Trigonellite found in a Scaphite from the Cretaceous rocks of the Upper Missouri country, the following description of this provisional genus is necessary for a clear understanding of the subject:—

As usually found, these bodies consist of one or two (most frequently two) ovoid or subtrigonal plates or valves, with one extremity truncated and generally wider than the other, and one side nearly or quite straight; while the outer or lower surface is a little convex, and the inner concave. Unless displaced or separated by some accidental cause, the two pieces always occur with the straight edges joined together in such a manner as to indicate that they were originally held together in some way. The normal position of the two pieces seems to be like that of the valves of a bivalve shell partly open; but when they are opened out and flattened by pressure, as is often the case, they frequently present the bilobate appearance seen in the annexed cut, Fig. 1. In structure, composition, and thickness they present differences, in consequence of which the group has been divided into the three following sections:—

Fig. 1.



1. The *CELLULOSI*, which are thicker than those of either of the other sections, and consist first of a thin, concentrically striated inner layer, over which there is a thick calcareous portion, composed of numerous polygonal tubes arranged with their longer axes at right angles to the outer and inner surfaces of the valves. Outside of this there is a thin calcareous layer, the smooth surface of which is usually perforated by small pores.
2. The *IMBRICATI*, with an inner layer like the preceding, and a middle porous stratum, the tubes of which are smaller and less distinctly defined. Its outer layer also differs in being a true calcareous shell, with distinct plications, and a smooth punctate surface, the punctæ of which are arranged in regular lines.
3. The *CORNEI*, which are said to consist of a single very thin corneous lamina, destitute of any porous or tubular layer.

Our Upper Missouri specimen, already alluded to, is very thin, and seems to be composed of a single lamina showing no cellular structure, and may consist only of the inner layer. It occurs in the outer chamber of a *Scaphites Cheyennensis*, and is the only organic body found in it, the surrounding space being filled with the fine indurated sedimentary matter, similar to that in which the Scaphite was originally enveloped. It occupies a position apparently about one-fourth of the distance back from the aperture to the first septum, and lies with the two valves partly open, and apparently in their natural position with relation to each other, their straight edges being joined together, and deflected upwards so as to form a distinct carina, which

¹ The reason offered by Mr. Darwin for rejecting the conclusion that these bodies are the valves of a Cirripede is, that they are nearly always found with the straight edges of the two valves or pieces in contact, so as to show that they must have been ankylosed or held together by a membrane or kind of ligament along these margins, which would have been impossible if they were the valves of a Cirripede, since that is the very side where the feet would have to pass out.

² They have been found associated with Goniatites in Devonian rocks.

³ See an example published by Mr. Woodward in the *Geologist*, vol. III, 1860, p. 328.

comes in contact with the so-called dorsal (properly ventral) side of the Scaphite; while the truncated ends of the valves (Fig. 1, *a, a*, which represents the valves of this specimen as it would appear if opened and flattened out) are directed forward towards the aperture.

The fact, however, to which we would call especial attention, is the occurrence of a third piece or appendage, differing entirely in form from either of the two valves already noticed, and, so far as we know, from anything hitherto found in connection with any of these fossils. This third piece occupies a position between the two valves as they lie together, partly opened; being nearer the extremity directed towards the aperture of the shell, and exactly fitting between the valves, as if in its normal position with relation to them. It is thin, and agrees so exactly, in color, texture, and surface markings, with the two valves enveloping it, that it is impossible to examine the specimen for a moment and entertain a doubt in regard to all three of these pieces being parts of the same fossil.

The appendage to which we allude differs entirely from the usual form of a Trigonellite or Aptychus, as generally understood, and presents a very peculiar jaw-like appearance. It consists of a single piece, with two thin rami or lateral expansions extending backwards so as to present, when viewed on either side, the outline and



appearance of the annexed cut, Fig. 4; while Fig. 3 represents its upper side. Its two lateral expansions, however (*a, a* of Fig. 3, and *c* of Fig. 4), have their upper margins inflected so as to appear, as seen from above, to be thicker than they really are. The position of this third piece between the two valves will be understood by reference to Fig. 2, the right end of the figure being that directed towards the aperture of the shell, and the lower or straight side being in contact with the so-called dorsal side of the same.

The presence of this third part or appendage would seem to furnish another strong argument, if any were necessary, against the conclusion that these fossils are the valves of Cirripedes, since its form is such that it can scarcely be regarded as homologous with any of the external plates of those animals. Its form, if not indeed its very existence, seems, we think, even more irreconcilable with the rather generally accepted opinion that they are opercula. We can readily understand how the two valves might be opened out and attached to a fleshy lobe, or some of the softer parts of the animal, so as to perform the offices of an operculum; but it seems impossible to conceive how this third jaw-like piece, which is manifestly a part of the same fossil, could be in any way connected with such an organ. In addition to this, it may be added that many Ammonites are known to have the aperture at maturity so remarkably contracted or modified by the development of lateral appendages of the lip, that it appears almost impossible that they could have been provided with an operculum.

In examining the curious third appendage described above, one can scarcely fail to be impressed with its resemblance to a jaw or beak. Indeed, so striking is this analogy, that we are strongly inclined to adopt that conclusion, notwithstanding the fact that we must then view the two¹ enveloping valves as forming together one of the opposing mandibles. The opinion that these bodies may be jaws instead of opercula—first suggested by Van Bréda, if we mistake not—receives additional support from the entire absence, so far as known, of anything else representing jaws or beaks, within the thousands of *Ammonites* that have been broken open in various parts of the world; while all the existing *Cephalopoda* are known to be provided with such oral organs. Again it will be remembered, that in the living *Nautilus* (the beaks of which are partly calcareous, and partly corneous), the upper mandible is received within, and enveloped by, the lower, much as the appendage we have described lies between the valves in our specimen.

Genus AMMONITES, BRUGUIERE.

Synon.—*Ammonites*, BRUGUIERE, Encyc. Meth. I, 1789, xvi and 28.—LAMARCK, Prodr. 1799, 80; Syst. Ann. 1801, 100; Phil. Zool. 1809, 323.—FERUSS. Tab. Syst. 1819.—ROISSY, Mol. V, 1805, 16, &c.

Planulites, Montfort, Conch. Syst. I, 1808, 78; (not LAMK. 1801?; nor MUNSTER, 1832.)

Ellipsolithes, Montf. ib. 86.

Argonauta, REINECKE, Mar. proto. Naut. 1818, * * * (not LIN.).

Ammonita, GRAY, Lond. Med. Rep. 1821.—FLEMING, Brit. Ann. 1828, 240.

Ety.—*Ammon*, a name of Jupiter.

Examp.—*Ammonites bisulcatus*, BRUGUIERE.

Shell discoidal or more or less convex, sometimes subglobose. Volutions contiguous or embracing at all stages of growth, and coiled in the same plane; umbilicus varying greatly in breadth and depth with the species. Surface costate, nodose, subspinous, striate, or smooth. Lip simple, inflected, or with various lateral appendages. Lobes and saddles of the septa more or less branched and deeply divided; the margins of the subdivisions sinuous and dentate.

In form, the dorsal position of the siphon, and often in ornamentation, the *Ammonites* present scarcely any difference from the *Ceratites* and *Goniaticites*. They differ from the latter, however, in having the lobes and saddles of the septa divided and variously branched or dentate, instead of simple. From the former they often present but slight and scarcely perceptible differences, even in the septa, the lobes of which only differ in being more or less deeply divided and branching, instead of merely serrated on their margins. There are, however, some intermediate species connecting these groups, so that even palæontologists do not always agree in regard to their position.

The *Ammonites* are also related to the genus *Scaphites*, from which they only differ in not having the last or body whorl of the adult shell deflected from the

¹ It is worthy of note in this connection, that M. Coquand has maintained that an *Aptychus* (as hitherto understood) properly consists of a single piece—that the apparent existence of two distinct valves, is produced by the fracture of a single flexed plate, along a mesial line of least resistance, from accidental pressure.

regular curve of the inner turns, and the aperture again turned back towards the body of the shell. In the position of the siphon, the structure of the septa, and in ornamentation, there is no difference between these groups; and it was probably only at maturity that the shell of a Scaphite differed from that of an Ammonite, while in some species this difference is very slightly marked.

The genus *Ammonites*, as here defined, was introduced at near the close of the Triassic epoch, though several authors improperly refer to it some of older Goniatices.¹ It is very numerously represented through the Jurassic and Cretaceous series, some eight hundred or more species having been already described from these rocks. As might be expected, the species of so large a group present great diversities of form and ornamentation, and various attempts have been made to group them into sections or subgenera, without any great degree of success. When we observe the remarkable differences, however, presented by the form of the aperture, and the labial appendages of some of the species when found entire, we are led to suspect that we may some time be able to separate them into several natural groups, either having the rank of genera or subgenera. We have no authentic evidence of the existence of this genus after the close of the Cretaceous epoch.

Ammonites cordiformis.

(PLATE V, Fig. 2, a, b, c, d, e.)

Ammonites cordiformis, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 57; ib. Oct. 1860, 418.

Comp. *A. cordatus*, SOWERBY, Min. Con. vol. I, 1812, 51, 17, figs. 2-4; also D'ORBIGNY, Pal. France I, pl. 193; Geol. Russia, pl. 34, figs. 1-5.

Shell lenticular, adult specimens being much more convex than the young; umbilicus rather small, or from one-third to one-half the breadth of the outer whorl; dorsum carinate; volutions increasing so as to more than double their diameter every turn, each of the inner ones from one-half to three-fourths hidden within the ventral groove of the succeeding whorl. Surface ornamented by numerous small flexuous costæ, which, in crossing the sides, increase by division and intercalation so as to number two or three times as many at the periphery as around the umbilicus. In approaching the dorsum, they curve forward, and all cross the dorsal carina, to which, in young specimens, they impart a distinctly crenate outline.

Greatest diameter of a specimen divested of its outer whorls, 3.30 inches; diameter of its last turn, from umbilicus to dorsum, 1.63 inch; breadth of same, 1.46 inch.

The septa are not very closely crowded, and have each five lobes on either side, none of which are deeply divided, or very complex in their details. The dorsal lobe is a little wider than long, and has two principal branches on either side, the two terminal of which are slightly larger than the others, and each provided with seven or eight unequal digitations. The dorsal saddle is about the size of the superior lateral lobe, contracted in the middle, and divided at the extremity into some four or five short, unequal, sinuous, and digitate branches. The superior lateral lobe is as long as the dorsal lobe, but narrower, conical in form, and ornamented with three or four lateral branches on the dorsal side, and two or three smaller ones on the ventral side; while its terminal branch is bipartite, and its margins, as well as those of all the other principal divisions, are more or less sinuous and digitate. The lateral saddle is smaller than the superior lateral lobe, and has on each side three or four very short, obtuse subdivisions, with sinuous margins. The inferior lateral

¹ The species in the Upper Trias have more simple septa, and often closely approach the genus *Ceratites* in this respect.

lobe is smaller than the lateral saddle, and divided at the extremity into two nearly equal, rather short branches, each of which is sinuous, and shows a disposition to give off short subdivisions on the outer side. The remaining lobes are very small, and obtusely digitate, the inner one showing a tendency to bifurcate.

This species varies considerably in form, as well as in its surface markings, at different ages; young specimens being much more compressed, more sharply carinate on the dorsum, and having a proportionally wider and more shallow umbilicus than the adult. Their costæ are also more flexuous and more sharply elevated than those of mature shells. On medium-sized specimens the costæ that pass entirely across the sides sometimes swell a little near the umbilicus, so as to form very obscure, transversely elongated, subnodose prominences; while on large specimens all the costæ are nearly or quite obsolete.

If *Ammonites cordatus*, of Sowerby, varies as much as it would seem to do from the figures of it given by D'Orbigny in the Palæontology of France, and in Murchison, De Verneuil, and Keyserling's work on the Geology of Russia, our shell may prove to belong to that species. In form and external ornaments it is almost exactly like some varieties of *A. cordatus*, yet it presents rather marked differences in its septa from any of the figures of that species we have seen; not greater, however, than we see between the septa of supposed individuals of that extremely variable form, represented by D'Orbigny in the Pal. France, and in the Geol. Russia. Although later comparisons have nearly satisfied us that our shell is not distinct from Sowerby's species, we have concluded to retain our name, *cordiformis*, until its identity or difference can be determined by the comparison of a better series of specimens.

Locality and position.—Southwest base of the Black Hills, associated with *Belemnites densus*, *Eumicrotis curta*, and other Jurassic fossils. (Type No. 203.)

Ammonites Henryi.

(PLATE IV, Fig. 9, a, b, c.)

Ammonites Henryi, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 57; ib. Oct. 1860, 418.

Shell convex-lentilar; dorsum narrowly rounded or subangular; umbilicus very small or nearly closed. Volutions about doubling their diameter every turn; inner ones entirely hidden within the profound ventral groove of each succeeding whorl. Surface apparently without nodes or costæ.

The septa are rather closely crowded, but their lobes and saddles are not very deeply sinuous, or complex in their subdivisions, and differ somewhat in their details on opposite sides of the shell. None of our specimens are in a condition to show very clearly the whole of the dorsal lobe, though it appears to be as long as the superior lateral lobe, and has at the extremity two small approximate terminal divisions, each of which is provided at the end with three or four small digitations; above these there is on each side one broad, but short, bifurcating, and more or less digitate lateral branch, and, above that, one or two subordinate lateral sinuosities. The dorsal saddle is about as large as the superior lateral lobe, a little oblique, and has at the extremity two short, nearly equal, digitate divisions, each of which shows a tendency to bifurcate. Below these there is on each side one lateral branch. The superior lateral lobe is as large as the dorsal, somewhat obliquely conical, and tripartite at the extremity, the divisions being small, subequal, divergent, and

merely digitate; above these there is on the dorsal side one digitate lateral branch, and on the ventral side one or two lateral digitations. The lateral saddle is much smaller than the dorsal saddle, more or less oblique, and ornamented at the extremity by some five or six very short, palmately spreading, obtuse divisions. The inferior lateral lobe is as wide, but scarcely half as long, as the superior, and on one side of the shell divided to its very base into two small, nearly equal, digitate parts; while on the other side of the shell it is narrower, and tripartite. Between this and the umbilicus there are about three very small, rather distant, digitate ventral lobes.

This species is quite distinct, in the structure of its septa, from all the other Ammonites yet known in any of the Nebraska rocks, and we are not acquainted with any nearly allied forms amongst foreign species. The only specimens of it we have seen are somewhat distorted, and consist of the inner septate whorls. One of these measures 3.10 inches in its greatest diameter, and 1.33 inch in breadth.

The specific name was given in honor of Prof. Joseph Henry, Secretary of the Smithsonian Institution.

Locality and position.—Southwest base of the Black Hills, in the upper Jurassic rocks of that region. (No. 314.)

ORDER **Dibranchiata.**

SUBORDER DECAPODA.

FAMILY BELEMNITIDÆ.

Shell (internal) consisting of a somewhat nacreous pen, expanded in front, and terminating posteriorly in a thin chambered cone, with simple septa, called the *phragmocone*, which is sometimes enveloped in a strong subcorneous or calcareous guard, having a radiated semi-fibrous structure. Chambers of the *phragmocone* connected by a ventral siphon.

Although this family is entirely extinct, specimens of one of the genera (*Belemnoteuthis*) have been found in such a state of preservation as to give a tolerably correct idea of the softer parts of the animal. From these it has been ascertained that it was provided with arms and tentacles of nearly equal length, armed with corneous hooks. The mantle was free all around, and the fins medio-dorsal.

This family embraces the genera *Belemnites*, *Xiphototeuthis*, *Belemnitella*, *Acanthoteuthis*, *Belemnoteuthis*, *Conoteuthis*, and *Helicurus*.

Genus BELEMNITES, AUCT.

- Synon.*—*Belemnites*, LISTER, 1678, and (in whole or part) of various other pre-Linnæan authors.—SCHROTER (part?), Lith. Lext. 1779, i. 151; Vollst. Einl. 1784, IV, 149.—ROISSY (part), Moll. V, 1805, 43.—CUVIER (part), Regn. An. 1817, 371.—D'ORBIGNY, Palæont. Fr. Ter. Cret. 1, 1840, 37; An. Sci. Nat. XVII, 1842, 241; Moll. Viv. Et. Foss. I, 18**?, 459 and of many later writers. (Not *Belemnites*, LAMARCK, Prodr. 1799, 81; nor Syst. An. 1801, 104; nor An. Sans Vert. 1822, VII, 590, which is *Belemnitella*, D'ORBIGNY.)
Paclites, MONTFORT, Conch. Syst. I, 1808, 318.
? Thalamus, MONTF. 1808, ib. 322.
Achelois, MONTF. 1808, ib. 358.
Callirhæ, MONTF. 1808, ib. 362.
Cetosis, MONTF. 1808, ib. 370.
Acamas, MONTF. 1808, ib. 374.
? Chrysaor, MONTF. 1808, ib. 378.
Hibolithes, MONTF. 1808, ib. 386.

Porodragus, MONTF. 1808, ib. 390.

Belemnita, FLEMING, Brit. Anim. 1828, 240.

Notosiphites, DUVAL-JOUVE, Belemn. 1841, 64.

Gastrosiphites, DUVAL-JOUVE, ib.

Etym.—Βέλεμαρον, a dart.

Examp.—*Belemnites Puzosianus*, D'ORBIGNY.

Pen consisting of two parallel, nacreous, sword-shaped processes, extending forward from the anterior dorso-lateral margins of the phragmocone. Guard elongated, cylindrical, more or less clavate, or somewhat compressed; becoming very thin anteriorly, where it is pierced by a deep conical cavity with entire margins, for the reception of the phragmocone; solid and more or less pointed at the posterior extremity. Phragmocone often terminating in a minute bulb at the apex; septa nearly horizontal, concave; siphon contracted where it passes through the septa, and somewhat expanded between them.

Animal unknown.

The guards of *Belemnites*, popularly called "thunderbolts," are the part most frequently met with. They generally have a semi-translucent, somewhat horny appearance, and a fibrous structure, the fibres radiating from a longitudinal, sub-central line. It varies greatly in form and size in the different species and varieties, as well as, apparently, in the two sexes. Sometimes it only extends about half an inch beyond the phragmocone, while in other instances it attains a length of one or two feet. It is readily distinguished from the guard of the allied genus *Belemnitella* by the absence of a slit down the anterior wall of the pierced end, and by having no distinct vascular markings on the ventral side. It also wants the flattened ridge always seen on the dorsal side of well preserved specimens of *Belemnitella*.

The genus has been divided into the following sections and subsections:¹—

SECTION 1. **Acœli**, BRONN. Without dorsal or ventral grooves.

a. *Acuarii*, without lateral furrows, but often channelled at the extremity. (Lias and Neocomian).

Type.—*B. acuaris*.

b. *Clavati*, with lateral furrows.

Type.—*B. clavatus* (Lias).

SECTION 2. **Gastroœli**, D'ORBIGNY. = **Notosiphites**, DUVAL. Ventral groove distinct.

a. *Canaliculati*, no lateral furrows. (Oolites.)

Type.—*B. canaliculatus*.

b. *Hastati*, lateral furrows distinct. (Upper Lias and Gault.)

Type.—*B. hastatus*.

SECTION 3. **Notocœli**, D'ORBIGNY. = **Gastrosiphites**, DUVAL. With a dorsal groove and furrow on each side.

Type.—*B. dilatatus* (Neocomian).

The great numbers of the guards of *Belemnites* often found imbedded together in the same stratum indicate that these mollusks were gregarious in their habits, and they are supposed to have preferred muddy bottoms. The genus made its appearance near the beginning of the Liassic epoch, during which it seems to have attained its greatest development. It continued, however, to exist until about the middle of the Cretaceous period.

¹ Woodward's Man. Mol. p. 74

The synonymy of this genus is involved in some obscurity. We have not been able to consult all the works in which the name was used, between the establishment of the binomial system by Linnæus, in his 10th ed. Syst. Nat. 1758,¹ and the publication of Lamarck's Prodrôme, in 1799. Consequently we have no means of determining, beyond doubt, whether or not any of these authors used it in accordance with the established usages of the Linnæan nomenclature before Lamarck. It is highly probable, however, that they did not; and if any of them did, it is more than probable they included both groups—that is, *Belemnites*, as usually understood, and *Belemnitella*, D'Orbigny. In the first case, Lamarck would be the first binomial author that used it, and hence the author of the genus; and in the second case, he would be the first to select the type of the genus. In first using the name in 1799, he gave a diagnosis, but mentions no type or example. In 1801, however, he uses exactly the same diagnosis, and mentions *B. paxillosus* (referring to Breynius's figures) as his only typical example. As this example, beyond doubt, belongs to the type long afterwards named *Belemnitella*, it follows that if we regard Lamarck as the author of the genus, or as the first to select its type, that the name *Belemnites* will have to be retained for the *Belemnitella* group. If so, then Montfort's name, *Paclites*, 1808, would have to be used for the group here described, and the name of the following species would have to be written *Paclites densus*. Not having the necessary works at hand to clear up all these doubtful questions respecting the synonymy of this genus, we have concluded to use for the present at least, the generally accepted name *Belemnites* for this group.

Belemnites densus.

(PLATE IV, Fig. 10, a, b, c and Pl. V, 1, 1a, b, c, d, e, f, g, h.)

Belemnites densus, MEEK & HAYDEN, Proceed. Acad. Nat. Sci. Phila. March, 1858, 58; ib. Oct. 1860, 418.

Shell or guard large and thick, subcylindrical, more or less compressed laterally, the cross section having a slightly oval outline. Lower portion tapering to a point; sometimes a little oblique, usually more compressed than any part above; rarely having, at the immediate point, a narrow, obscure groove on the ventral side, and a very slight carina on the dorsal side. Surface smooth. Alveolar cavity apparently extending about half way down from the summit, and terminating nearly midway between the centre and the ventral side; from this point the axial line passes down, gradually approaching the ventral margin, but curving slightly, so as not to intersect it before reaching the extremity. Phragmocone very slightly curved; apical angle 20°. Septa rather closely arranged, about twenty of them occurring in a section one inch in length, measuring 0.72 inch in diameter at the larger end, and 0.35 inch at the smaller extremity; siphon unknown.

The most nearly complete specimen of the guard we have seen measures 5 inches in length, and 0.90 inch in diameter at its larger end. The alveolar cavity of this specimen is 2.39 inches in length, and 0.75 inch across at the aperture, which is slightly oval. Some fragments in the collection, however, appear to have belonged to individuals at least one-third larger than that from which these measurements were taken.

This Belemnite is very closely related, in most of its characters, to *B. Panderianus*, D'Orbigny, as figured in Murchison, De Verneuil, and Keyserling's work on the geology of Russia, vol. 2, pl. 30. The only differences we have observed are that

¹ Linnæus never adopted *Belemnites* as a generic name, but merely used it as a kind of specific name, under *Helmintholithus*, in which he included nearly all kinds of fossils. See Syst. Nat. xii. ed., 1768, iii. 162. Gmelin used it in the same way in xiii. ed. Syst. Nat. iii. 413.

the section of all our larger specimens is more nearly circular, and they appear never to possess the broad, shallow groove represented by D'Orbigny's figures, on the ventral side, near the apex. Some individuals have on that part of the shell a linear groove, but it seems never to widen upwards as represented in *B. Panderianus*. There is also on some of our larger specimens a slight carina near the apex of the dorsal side (Fig. 1g, Pl. V), not represented by D'Orbigny's figures, nor mentioned in his description.

Along with these large specimens we find several smaller ones, having a proportionally more slender form, and a more nearly central axial line. Some of these also have a quite distinct, though narrow, ventral groove (Figs. d, e, f, Pl. V), while their transverse section varies from subcircular to oblong-oval. These, we suspect, belong to a distinct species, but, without better and more extensive collections for comparison, we have not been quite able to satisfy ourselves they may not be younger individuals of the more robust form. These two varieties appear to bear exactly the same relations that the large and small specimens of *B. Panderianus* figured by D'Orbigny do to each other.

Locality and position.—Southwest base of the Black Hills, associated with *Eumicrotis curta*, and other Jurassic fossils. (Type, No. 195.)

SUBKINGDOM ARTICULATA.

CLASS ANNULATA.

ORDER Tubicola.

FAMILY SERPULIDÆ.

Enveloping tube more or less calcareous, or membranaceous.

Animal vermiform, rounded or somewhat compressed; segments short. Head lobe soldered to the oral segment, and not distinct in the adult. Oral segment with a pencil of setæ on each side, and generally provided with a collar. Mouth directed forward, without a proboscis, situated between the bases of the branchial plumes. Branchiæ two, one on each side, either semicircular, circular, or spirally coiled; consisting of a basal membrane, from the anterior margin of which the threads arise, either in a single or double row. Setæ simple and of two kinds, capillary or hooked.

The recent genera included in this family are *Anisomelus*, *Sabella*, *Eriographis*, *Protula*, *Serpula*, *Spirorbis*, *Filograna*, and *Fabricia*.

The fossil forms described under the names *Hamulus*, *Spirulæa* (or *Rotularia*), *Cyclogyra*, *Serpulites*, *Trachyderma*, &c., probably also belong to this family.

Genus SERPULA, LINNÆUS.

Synon.—*Serpula*, LINNÆUS, Syst. Nat. 10th ed. 1758, 786; ib. 12th ed. 1767.—BRUG. Encyc. Meth. I, 1792, xiv.—

LAMARCK, Syst. An. 1801, 325.—BLAINV. Dict. Sci. Nat. XLVIII, 1827, 549, &c.

Etym.—*Serpo*, to creep.

Examp.—*Serpula vermicularis*, LIN.

Tube calcareous, procumbent, variously curved or spirally coiled, growing singly or in groups, attached to marine bodies; capable of receiving the entire animal. Aperture at the larger extremity simple and rounded.

Animal without feet; mouth not provided with tentacles. Branchiæ large, pectinated, flabellate, with bearded lacinæ, and a cylindrical filament at the base of each, differing in length in each of the branchiæ, the longer sustaining an orbicular disk, or funnel-shaped operculum.

This genus is closely related to *Spirorbis*, which some authors include as only a section of the same group. As these two types, however, differ in their branchiæ, as well as in the regularly coiled, *Planorbis*-like form of the tube of *Spirorbis*, they are doubtless distinct genera.

The shells of these Annelids were formerly supposed to be those of true mollusks, but as soon as naturalists examined the animal inhabiting them, it was found to belong to the *Articulata*. Where we only know the shelly tubes, however, as is of course always the case with the extinct species, it is very difficult to distinguish species of this genus, not merely from the allied genera, but even from *Vermetus*, a true mollusk. Consequently much confusion exists in the classification of the fossil species, and for the same reason the geological range of the genus is not well determined. Some authors refer to it Devonian, and even Upper Silurian species; but it is quite probable that if we had any means of ascertaining the nature of the animals once inhabiting these shells from the older rocks, they would be found to all differ generically from the more modern and existing *Serpulas*. The number of supposed *Serpulas* is found to increase as we ascend through the Carboniferous and later deposits, and the genus appears to attain its maximum development at the present time. The recent species are numerous, and attach themselves to stones, shells, pieces of wood, the bottoms of ships, &c., and are widely distributed.

Serpula (UNDT.)

(PLATE V, Fig. 4.)

Tubes growing in small groups, irregularly curved, slender, increasing gradually in size; having a distinct carina along the middle above, and a more obscure angle along each upper outer side, so as to give a subquadrate external form to the transverse section. Under side flattened, and inclined to spread out a little on the surface to which it is attached. Aperture and transverse section of interior circular. Surface apparently smooth, or only having very obscure marks of growth.

Length, apparently, never more than about 2 inches; greatest diameter, about 0.15 inch.

This species resembles rather closely some of the Jurassic forms figured by Goldfuss and others; but all our specimens being worn or weathered so as to obliterate, to a great extent, the more delicate surface characters, we do not feel warranted in identifying it with any foreign species, nor are we clearly satisfied that it is new.

Locality and position.—Southwest base of the Black Hills. Lower part of the Jurassic rocks of that region. (Type, No. 219.)

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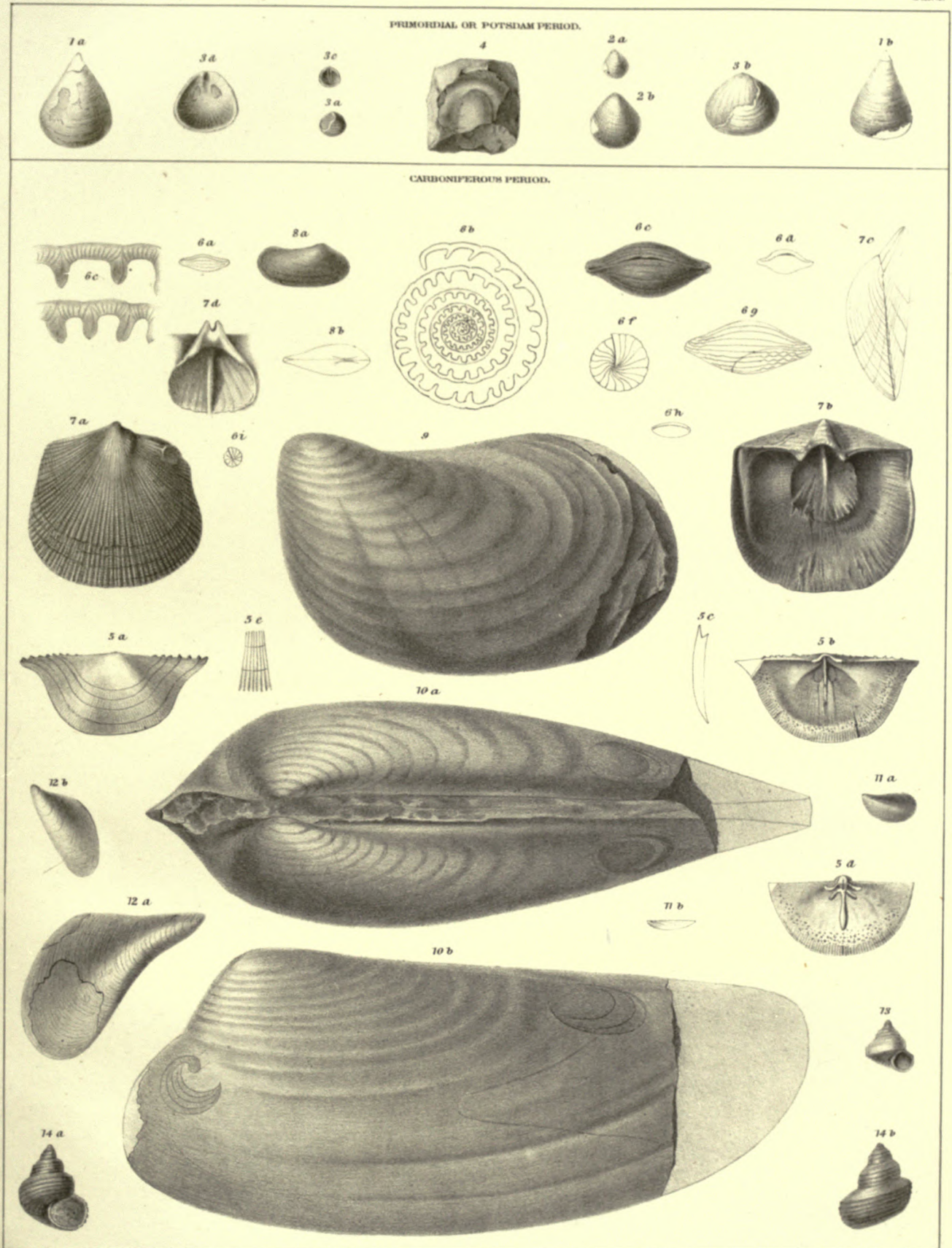
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PL. II.



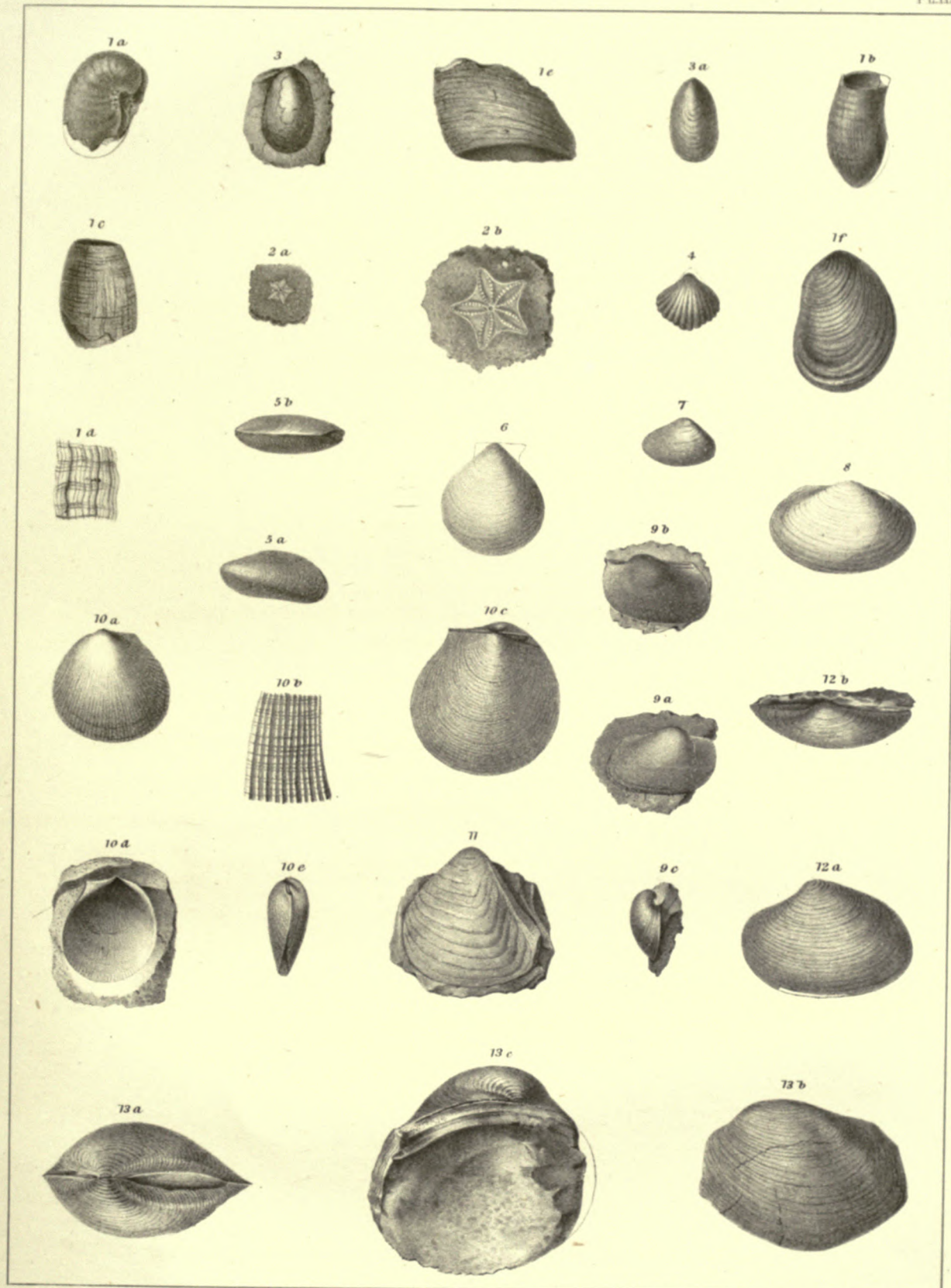
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TRIASSIC AGE, JURASSIC PERIOD.

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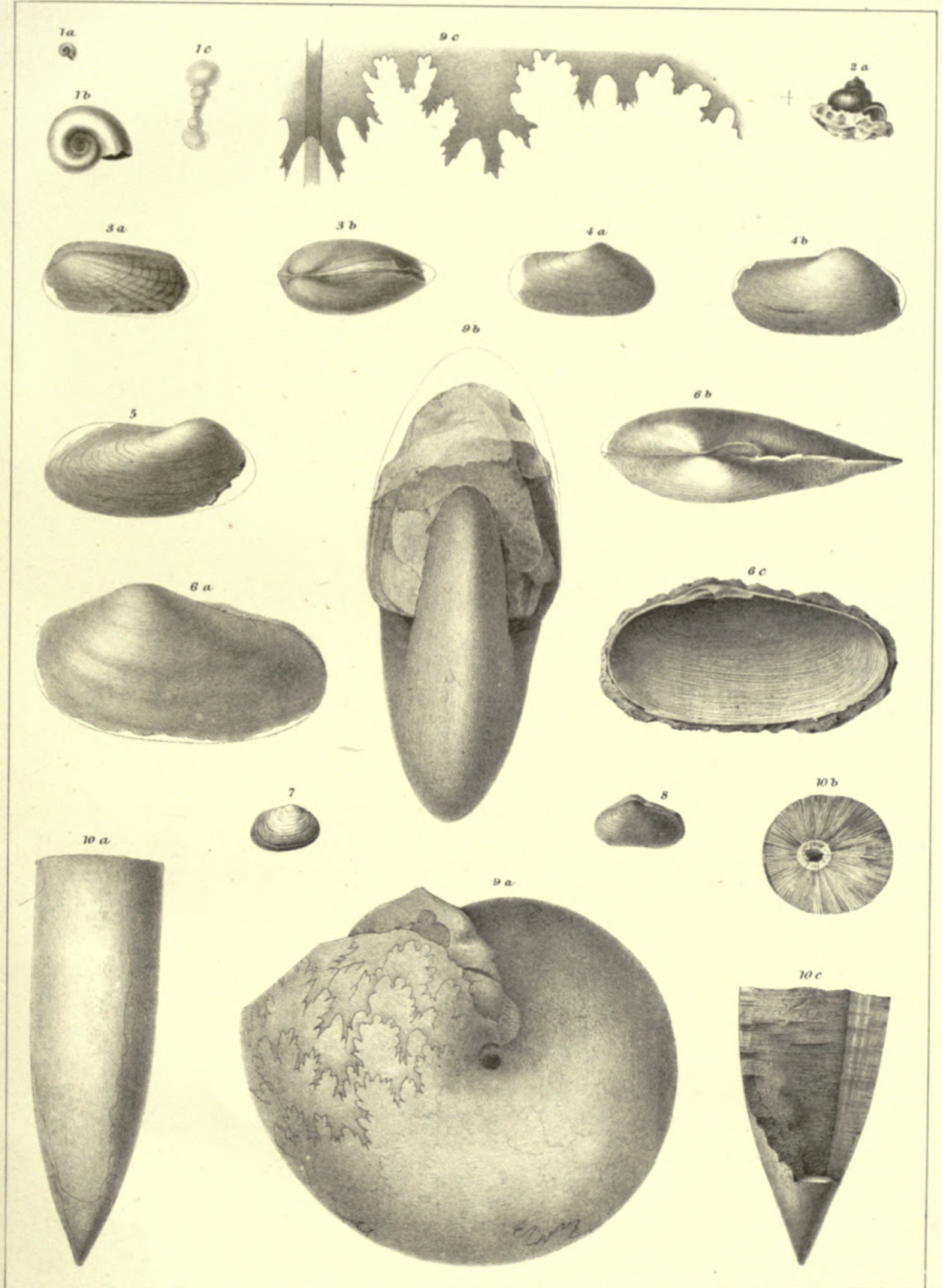
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REPTILIAN AGE, JURASSIC PERIOD.

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TRIASSIC AGE. JURASSIC PERIOD.

PL. V.



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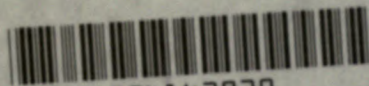
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